corduroy roads were laid on soggy stretches. This habit persisted until very recently, when the popularizing of the automobile made corduroy roads no longer endurable.

The corduroy surfaces were rough, but of more importance, they had been laid largely in creek and river bottoms subject to overflow. In building a corduroy road a level surface was essential for the length of the pole; and labor being plentiful and earth-moving equipment scarce, the ante-bellum road builder obtained this level surface by digging and not by filling, as would be done now. We thus have roads through bottom lands as low or lower than the surrounding surface.

So heavy is the rainfall in the South and Southeast that high floods are customary, and while often a long-legged steer or horse could get over the submerged roads, modern low-hung automobiles cannot. Flood levels of 6 to 8 ft. or more are often found on these old corduroy roads making them quite impassable.

Reconstructing the Old Roads

The predominating kinds of timber dug out of the later-built roads are ash, sweet gum and pine. Much cedar, locust, sassafras, oak, etc., was used previous to the war. Long-lasting woods, like cedar, sassafras, white oak and locust, are still good, and if it were known that these woods only had been used, the improvement could be made on top of the old road. Other woods have decayed, or are decaying, and therefore the removal of the corduroy road must be considered in rebuilding these highways.

Five methods of rebuilding are practicable: (1) Machine excavation; (2) hand excavation; (3) burning; (4) filling over the corduroy; (5) relocating the road.

Plan 5 is much used. In the first place there was no inclusive scheme used in laying out these roads—there may be several roads in the course of a few miles and there may be 5 mi. between the next two. Grades are either steep, or the road over the elevation is unnecessarily roundabout. As the surface of roads should be high enough to provide drainage, it is usually found more costly to fill the excavation made for a corduroy road than to grade a new roadbed.

Where cleared land is available for a new location and condemnation proceedings are not forced, a relocation is the most economical solution of the problem. Nevertheless this cannot always be done. Again, the corduroy roads have been mostly in river-bottom lands, where timber or heavy brush is generally found, so that any estimate for a relocation must consider the cost of clearing a new right-of-way.

Plan 4 is used where relocation is undesirable and where the finished surface of the roadway is to be 30 in. or more above the buried wood. In this case, for the gravel road now largely being built throughout rural Virginia, at least 18 in. of soil from near-by borrow pits is filled in over the old road, then 12 in. of bank-run gravel is spread for surfacing material. The cushion of soil is usually compacted by rolling in about 18-in. layers. The gravel is not compacted except by the teams and wagons hauling it.

Control of the Traffic Loads

Thus cheaply built and well-maintained, this type of soil-gravel road has been found suited to moderate automobile traffic, and it will hold its surface if heavy loads are prohibited while the surface and soil cushion are soggy from thawing or long wet periods. In the South roads are subjected to continuous freezing and thawing all through the winter, which is extremely trying to any type of earth road. Frequent rains are experienced also. By several state laws boards of supervisors are given authority to control loads on improved highways, and this authority is now largely exercised, the limit being 1000 lb. per wagon when the roads are thawing or soggy.

Perhaps 75 per cent. of the heavy traffic over Southern rural roads has heretofore been in lumber and allied industries, the little country sawmills sending their product to rail or water by two-, three- and four-mule wagons. Lately, some tractor hauling has been tried with fair results, although it is found that curves are of too short radius and grades too abrupt for much success at this time with the wagons used. No effort has been made to secure special trailers, and a long string of ordinary wagons is very unwieldy.

Cross-ties, excelsior, pulp and cordwood are produced whenever farm work is slack, as well as sawed timber. Regulations limiting loads are opposed by many at first. This quickly ceases, however, when it is seen that reducing the loads for the short periods required enables good loads to be hauled all through the winter, instead of diminishing the load as the winter proceeds because of the total demolition of the road surfaces.

Where a road cannot be relocated and filling over the old corduroy surface is impracticable, the poling can be removed in one of three ways. It depends on conditions which is the most economical. Burning is not extensively

FIG. 3. FLOOD PROTECTION BY WOVEN BRUSH
Screens of woven brush are fastened to the fence posts to prevent scour

FIG. 4. A 70-YEAR-OLD RURAL ROAD
Drainage ditches 12 ft. deep, overgrown with brush and dangerous

practiced and is confined to roads in clay soils generally classified as gumbo. A fire dries out this material so it can be compacted without gumming up the road-roller wheels. This kind of clay must be well compacted, for otherwise the gravel will work down into it and in rainy weather ruts will cut clear through the gravel. However, the burning of the poling is only a part of the fire applied, much brush being burned also.

To burn the poling the earth covering is first dragged off with a road scraper with the blade set horizontally. The poles are then allowed to dry out, when some handy inflammable fluid is applied. This will cover the poles most effectively if sprayed on in a moderately heavy spray. The fire should be set to burn against the wind, as otherwise it will sweep over the poles without generating its full heat.

No cost data are at hand to show the relative efficiency of machine and hand methods of uncovering the poling, but it is evident that with the ordinary road machine found in most Southern districts, hand digging is not any more expensive. The only machine usually available is the blade scraper, which has so low a clearance that the outfit must stop every few feet to clear out the material from under it. In hand digging the earth covering the poling is first scraped off, when a heavy subsoil plow may be run near each end of the poles, the point plowing down under the poles. This rips up the sound poles, which are then carried off to suitable piles. The rotten poles are broken up by this process and must be dug out by hand.

Sound poles of lasting wood, like cedar, locust, white oak and sassafras, can be dried out and worked into fence posts selling from 10 to 25c. each.

It would appear sound to estimate from $100 to $500 per mile for digging out old corduroy roads when bidding on Southern road work, where much poling is found and the specifications require its removal.

The Australian Transcontinental Ry. will be finished by the end of 1916, according to a recent report by the Chief Engineer, N. G. Bell. On the West Australian section the final locating survey has been made for a distance of 260 mi. and preliminary surveys as far as the South Australian boundary. The line has been completed ready for track laying for 240 mi. in West Australia and 264 mi. in South Australia.

New Trenching Machines

A special class of excavating machinery which has been developed very extensively is that for digging the deep and narrow trenches required for water mains, sewers and tile drainage. Two excavators, of different types, for this class of work, are shown in the accompanying illustrations. They are being introduced by the Pawling & Harnischfeger Co., Milwaukee, Wis.

Ladder Excavator

The machine shown in Fig. 1 has an endless chain fitted with buckets, the chain being carried by a boom or ladder frame which has its upper end pivoted to fixed frames on the deck of the machine. The ladder is a heavy box girder, which is held at the required position by tackle from the cantilever ends of the fixed frames. Its weight serves to hold the buckets against the breast of the cut, and the method of suspension enables it to swing up if the buckets strike a heavy boulder or other obstacle.

The buckets are of cast steel, with removable teeth of tool steel, and are attached to a chain composed of cast-steel links having a pitch of 10 in. The buckets can be changed readily to give the desired width of trench. Ordinarily the range of work is 12 ft. in depth and 27 to 39 in. in width; but an extension of the ladder provides for a depth of 15 ft., while buckets of greater width can be used if necessary. The contents of the buckets are dumped upon a transverse 24-in. belt conveyor of suitable length, which can be extended on either side. A scraping device insures the complete discharge and cleaning of each bucket.

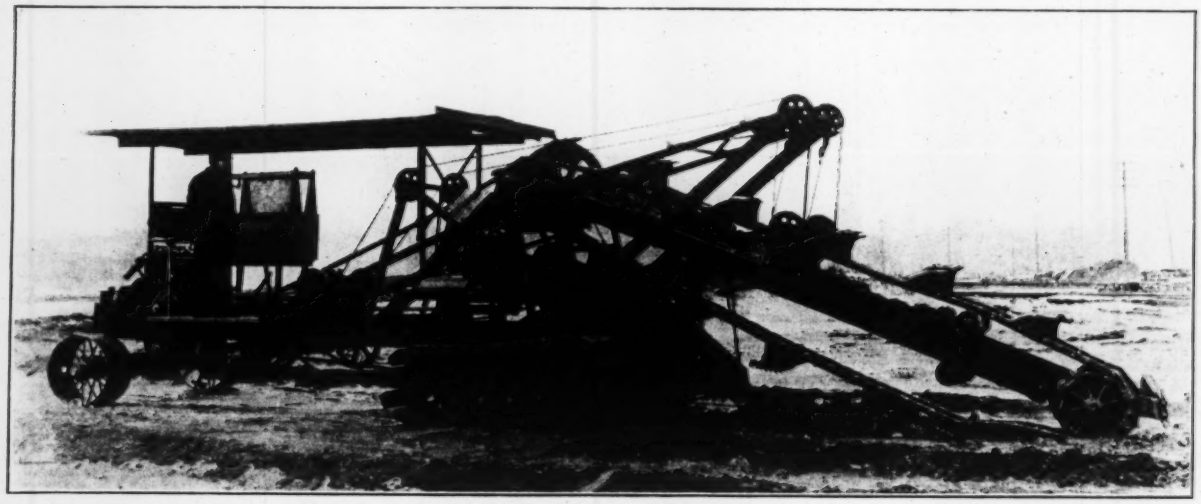


FIG. 1. TRENCH EXCAVATOR OF THE LADDER TYPE FOR SEWERS, WATER MAINS, ETC.

The machine has a steel frame 22 ft. long, to which are attached the cantilever frames carrying the end bearings and the hoisting sheaves of the ladder. It has a pair of 34-in.-wide tired wheels at the front, while at the rear are a pair of caterpillars 7 ft. long and 30 in. wide. These caterpillars have their frames pivoted on a heavy cross-shaft, so that they can accommodate themselves independently to the inequalities of the ground. They are driven by sprocket chains. A bevel-gear differential equalizes the strains when turning curves, and brakes on the chain sprockets provide independent control of the caterpillars to assist in making very short turns.

Power is furnished by a 70-hp. four-cylinder vertical engine, which can work on gasoline, kerosene or motor spirit. This is geared to a countershaft, from which the upper tumbler of the ladder chain is driven by a steel roller chain. The caterpillars, the feed gear and the ladder hoist are all driven from this shaft by means of chains. The feed is through a gear train which gives six rates of speed, ranging from 1¼ ft. to 5 ft. per min. The ladder hoist is operated through bevel gears and a worm gear. The steering is effected by a hand-operated gear driving a shaft having drums, from which chains are led to the front axle.

The operating levers are so grouped that all movements can be controlled by one operator. The machine is 52 ft. long over all, and weighs about 22 tons in working order. It has been used on sewer trenching work in Chicago.

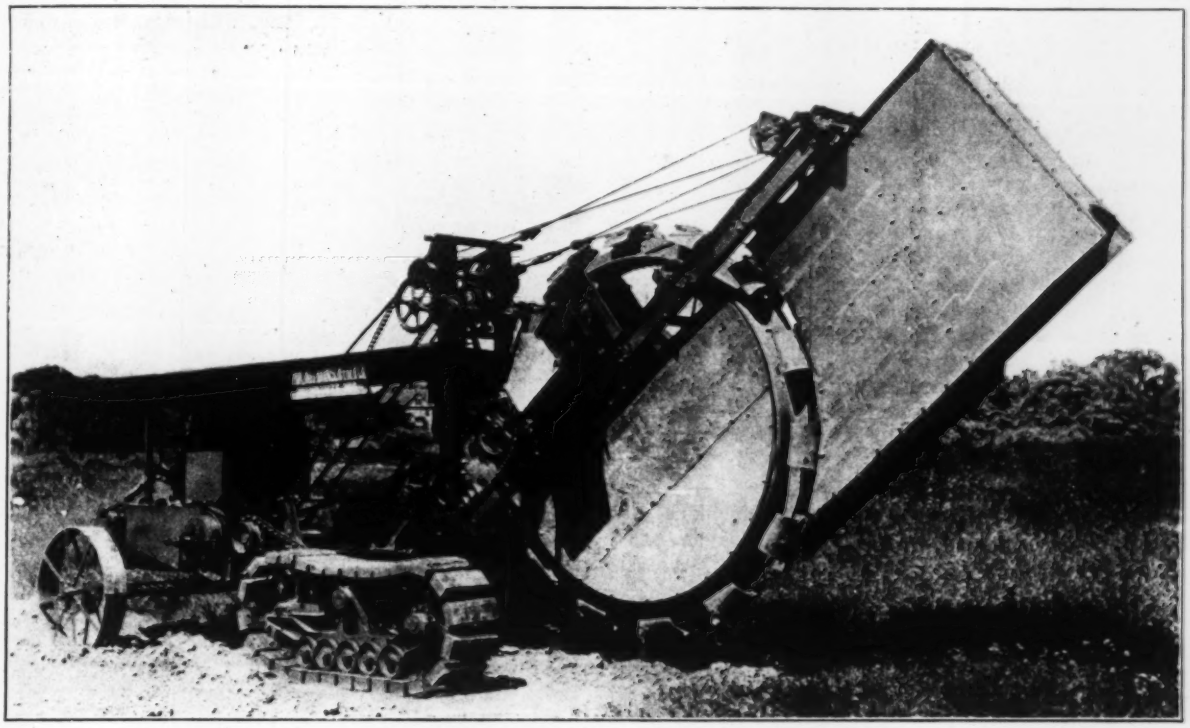


FIG. 2. TRENCH EXCAVATOR OF THE WHEEL TYPE, USED MAINLY FOR TILE-DRAINAGE WORK

Wheel Excavator

This type of machine is used mainly in tile ditching or drainage work, but is also employed for pipe lines, etc. The wheel which carries the excavating buckets has no axle, but the inner face of the rim rides on friction rollers carried by a frame within the wheel. A pinion driven by a sprocket chain engages an internal gear on the rim. The wheel is inclosed by a steel housing as shown in Fig. 2 which serves to support the sides of the trench.

The box in the rear of the wheel is for the protection of the tile-layer, preventing the trench from caving in upon him. The bottom of the box forms a shoe to smooth the bottom of the trench and give it a concave form to receive the tile. The buckets are cleaned by a stationary spade or scraper, and knives or rooters can be added for work in hard material. The excavated material is delivered on either side of the trench by a steel chute when the spoil is to be delivered close by or by transverse conveyors composed of steel slats when it is to be carried some distance.

The main frame of the machine is supported by a pair of wheels on the steering axle and a pair of caterpillars at the rear. Upon it is a gallows frame carrying two pairs of drums. The upper drums are for the topping-lift cables which lead to the outer end of the boom carrying the wheel. The lower drums are for cables which are attached to a crosshead on the inner end of the boom, raising and lowering it in the vertical frame.

These machines excavate trenches up to 7½ ft. deep and 12 to 24 in. wide. Power is furnished by an internal-combustion engine of 20 to 45 hp., and the rate of feed varies from 1¾ to 7½ ft. per min. in machines of different sizes.

The accompanying table gives the record of work done by a wheel machine of the type shown on this page, used by C. D. & J. T. Pierson, of Terre Haute, Ind., for drainage ditching in gumbo soil.

PERFORMANCE OF A WHEEL EXCAVATOR ON TRENCH WORK FOR TILE DRAINAGE

Record	A	B	C	D	E	F
Hours worked	10½	11	11	11	11	12
Hours delay (incl. noon)*	3	3	2	2	3	2
Net working hours	7½	8	9	9	8	10
Gasoline, gals. (at 11½c.)	12	13	15	15	13	20
Cost of fuel and lub. oil	$1.68	$1.85	$2.17	$2.17	$1.85	$2.90
Number of men	3	3	3	3	3	4
Labor cost per day	$6.50	$6.50	$6.50	$6.50	$6.50	$8.00
Total cost per day	$8.18	$8.35	$8.67	$8.67	$8.35	$10.90
Trench (11½ in.), depth	42 in.	42 in.	42 in.	44 in.	42 in.	36 in.
Trench, length, ft.	1650	1952	2887	2310	2838	5032
Cost per lin.ft.	0.50c.	0.43c.	0.30c.	0.37c.	0.29c.	0.21c.
Cost per cu.yd.	3.98c.	3.45c.	2.41c.	2.89c.	2.37c.	2.04c.

* Delay includes 30 min. or 1 hr. at noon, and is mainly the time required to move the machine from one trench to another.

Difficulties Overcome in Sinking a Deep Well

By P. E. Green*

SYNOPSIS—In sinking a well about 1550 ft. deep at Oglesby, Ill., various difficulties such as cave-ins, lost tools, plant breakdowns and mine flooding were met and overcome by the contractor and the engineer.

Oglesby, Ill., situated in the Illinois River Valley near the junction of the Illinois and Vermilion Rivers, has recently completed a deep well for water-supply purposes. Some of the difficulties encountered during the work seem to be worth recording.

In the immediate vicinity of Oglesby the strata are very badly folded and broken up, but in the main there are about 20 ft. of overlying soil, about 500 ft. of various kinds of shales, all having a tendency to cave and disintegrate when exposed, about 300 ft. of dolomite and limestone with occasional layers of shales, and from that point to the St. Peter sandstone which was encountered about 1550 ft. below the surface, the rock is generally a variation of close-grained limestone, being solid and fine grained from 900 ft. on.

The city is situated over coal mines, the first at 225 ft. and the second about 500 ft. below the surface. These mines are absolutely dry mines, and hence there has been no provision made for drainage. These facts were brought to the attention of bidders for the well. In a well drilled about one mile distant, salt water had been encountered some 585 ft. below the surface and had developed a head of approximately 400 ft. The attention of bidders was called to this fact, also, but the successful bidder failed to make adequate provision for taking care of the salt water.

The well-drilling plant coasisted of a large timber tower for handling the well casing, drills, etc., a steam boiler and a single-cylinder noncondensing steam engine driving through a belt about 35 ft. in length a 10-ft. diameter wheel. This wheel, operating through a friction clutch and wire rope over the tower, handled the casing, tools, bailers, etc. The wheel also directly operated a large timber walking beam by means of which the drills were churned up and down. The tower was made of sufficient height to handle two 20-ft. lengths of pipe casing at one time.

Work was actually started Feb. 23, 1915. The first 20 ft. to bedrock, through loam and clay, etc., was cased with 18-in. internal diameter steel drive-pipe. No water was encountered. Then for 330 ft. the hole was cased with 14-in. internal diameter wrought-iron pipe, of the heavy screw-drive coupling type. The hole was dry all the way. At this depth, the 14-in. casing was set on a good shoulder and drilling proceeded with a 12-in. hole, which was cased with 10-in. wrought-iron drive pipe.

The casing passed through two coal mines, parts of which have been worked out and abandoned. In the second coal mine the 10-in. pipe passed through an old entry, from which the track had not been removed, though the entry (in solid rock) had been filled with débris from the active part of the mine. This casing ended 600 ft. below the surface, where it was set on a shoulder and sealed to the 14-in. casing with a lead packer. The hole continued dry to a point 815 ft. below the surface, where a small vein of salt water was encountered amounting to about 320 gal. per hr. At 875 ft. a heavy flow of salt water was struck, amounting to 2400 gal. per hr. This water was kept down with a bailer (an 8-in. cylindrical tube or pipe, about 25 ft. long, with movable bottom) which held 60 gal., and was operated by the tower and steam engine. The bailer, working at the rate of one trip per minute, could lower the water and permit intermittent drilling.

Cave-In of Uncased Well

At this time occurred a cave-in of the uncased well, the 10-in. casing on its shoulder being about 200 ft. above the bottom of the well. This cave-in was of such a character that the tools had to be abandoned temporarily and the rope was cut about 20 ft. above the top of the drill. A few hours later the boiler broke down, because of bad water. Here is where the real trouble started. The salt water now rose around the outside of the 10-in. casing and into the abandoned entry of the second mine, which was about 550 ft. below the surface of the ground and 330 ft. above the bottom of the hole. Ordinarily the weight of casing on its rock shoulder would shut off any water and prevent it from rising outside the casing, but the 10-in. casing had been sealed to the 14-in. with a lead packer to keep the salt water out of the well itself. Hence the 10-in. casing did not bear its full weight on the stone shoulder, but on the packer, and while it kept the salt water out of the well, it did not prevent its entering the mine. This mine had been worked for 40 years and was an absolutely dry mine; there was no provision for drainage and the entrance of 40 gal. of water per min. became a serious matter.

A Mine Flooded

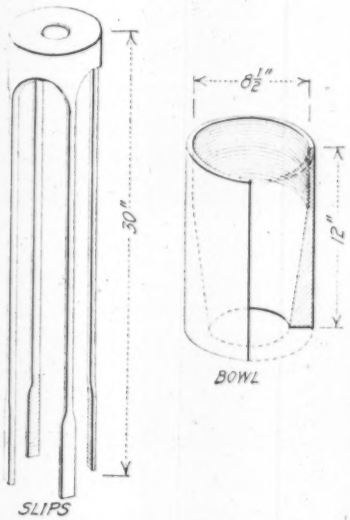
As soon as it was seen there might be trouble with the salt water, men were set to work by the mining company clearing out the abandoned entry, the distance to be cleared amounting to about 600 ft. Since the entry was low, only a few men could work at one time, and it took one week of work of two shifts of three men each to get to the well. The temperature in the entry was about 90 deg. F. and the ventilation poor. About the time the entry was cleared and the well casing exposed, the contractor's surface-boiler broke down, as stated, and several tubes had to be replaced. In addition the friction clutch, because of constant operation with the bailer, gave way and had to be repaired. The water at once rose rapidly into the mine and caused a great deal of apprehension, since thousands of dollars worth of property would be damaged by flooding and several hundred men thrown out of work. It took several days to get new tubes for the boiler.

*Civil Engineer, Aetna Engineering Bureau, 17 North La Salle St., Chicago, Ill.

The tools were lost on Apr. 4. The boiler and bailer had been worked continuously until Apr. 8, when the boiler broke down as related. The contractor had no other pump, the new boiler tubes ordered had not arrived, and in this emergency the engineer took charge and ordered a 5-in. deep-well pump, 600 ft. of drop pipe and a steam head, shipped by express from Chicago. They were ordered the night of Apr. 10 and arrived in Oglesby the next afternoon. The same morning, the boiler tubes arrived, were installed, and bailing was resumed.

Sealing the Mine Entry

The plant had been out of commission for three days, during which time several hundred feet of the mine had been completely flooded. Fortunately, for the entire distance of 600 ft., the mine sloped toward the well. During the morning of Apr. 11 the bailer started to lower this water and by the afternoon of Apr. 13 the water had been lowered so that the work of sealing the entry around the well casing could proceed. The heat in the entry was intense, only two men could work to advantage at a time and all material had to be brought from the surface down the shaft and through the main entry, a distance of one mile. When the well casing was finally exposed it was found that the drill in coming through the mine had threshed around considerably and that a cone-shaped hole extended for about 20 ft. below the floor of the mine entry. This hole was about 24 in. in diameter at the top, decreasing to about 14 in. at the bottom. It was carefully cleaned out, the walls washed and scrubbed and then filled with rich cement mortar. The well casing exposed in the mine was then cased in a column of reinforced concrete 6 ft. sq. quite to the roof of the mine. In less than 24 hr. after this was completed the bailer on the surface broke down, but the cement had set sufficiently so that the water was entirely shut off. After the bailer broke, the salt water continued to rise inside the well reaching a height of 785 ft. from the bottom, which was within about 100 ft. of the surface of the ground, the total head of salt water varying from 715 to 770 ft. From 815 to 840 ft. the material encountered was a good hard limestone, yet the first salt water flow was from this material. From 840 to 850 ft. the material was a slate. From 850 to 875 ft. were layers of limestone, clay and slate mixed and at 875 ft. the sand vein, from which the heavy flow of salt water came, was encountered.



BOWL AND SLIPS FOR RECOVERING WELL TOOLS

After the mine had been sealed off, operations were started for the recovery of the tools. When the tools were lost the contractor had ordered about 1000 ft. of 8-in. oil-well casing, the intention being to force this casing down through the cave-in and over the tools and then get hold of the tools with a grab tong or bowl and slip. The casing was ordered about Apr. 5 but did not arrive until Apr. 23 having been lost in the railway yards at Chicago in the meantime. From Apr. 14 to 23 the water stood at full depth in the well. Since the lower 200 ft. of the well was uncased at the time, the water caused the material to soften and disintegrate and much more of the well caved in, there being finally about 200 ft. of débris on top of the lost tools. This made their recovery very difficult. It had been the intention to drop the 8-in. pipe down over the tools, as it was thought that the first cave-in was simply a bridge, and that the 8-in. pipe could easily be driven through it. This was found impossible on account of the fact mentioned before that the well had further caved in for a distance of 200 ft.

Bowl and Bowl Slips

The débris was then drilled through in much the same manner as the original well, and when it was thought the drill was within 10 or 15 ft. of the tools a casing bowl was put on the lower part of the 8-in. pipe with the intention of forcing this over the tools. This bowl (see accompanying sketch) is a piece of pipe having one end threaded to screw over the 8-in. pipe, while in the other end the interior is cone shaped, with the small diameter at the bottom. The plan of operation was to force it down around the tools, then lower the grab tongs or bowl slips, as they are called, over the tools. The bowl slips (see sketch) consist of four spring steel prongs about 30 in. long, with the lower ends of the prongs flattened out to form a sort of paw, the four prongs constituting a cylinder. The inside of the paw end of the prongs has cut threads like a pipe wrench. Since these prongs are long they have a very considerable spring to them and hence the bowl attached to the pipe when pulled up tends to force the paws tight into the tools. The entire length of 800 ft. of casing is then pulled and the slips, contracted by the cone of the bowl, tightly clasp the head of the tools.

The first attempt failed, because the bowl could not be forced over the tools, for the reason that the original 20 ft. of rope which had been cut off when the tools were abandoned was found to have been churned into such a mass that the pipe could not be forced through it. All the 8-in. casing had then to be pulled out, the bowl taken off, the pipe dropped down and drilling started again.

Much trouble was encountered before the bowl was finally forced over the ends of the tools. On Apr. 27, 28 and 29 the space surrounding the lost tools was drilled with a spud, thus enlarging the hole and cleaning out and exposing the tools farther down. It should be noted that all drilling for the recovery of the tools was through the 8-in. casing hung from the top of the well. On Friday, Apr. 30, a hold on the tools was finally obtained with the bowl and slips. It was found impossible to budge the tools, however, with a straight pull. A double block was then put on the derrick with a bull hitch and when this was pulled the 8-in. casing pulled apart at the top nipple. The nipple was probably poorly threaded. The pipe was rethreaded and a new nipple supplied and then the linked "elevator," or cross arm upon which the straight pull was applied, pulled apart. This was Friday, May 7. The entire week had been taken up with these two unsuccessful attempts. On Saturday, May 8, a 6¼-in. drill was installed and again the drilling around the tools started, and for six days continued, when the hole around

the tools was 40 ft. deep. The 8-in. casing and the bowl and slips were dropped down over them and this time the tools pulled up for 10 ft. to refusal. They were then driven down with drills, the bowl and slip dropped over them again and the tools finally recovered on May 17, a total of six weeks after losing them. The cost of fishing was $720 for labor, and $180 for other expenses, making a total of $900.

After the tools had been recovered the drilling proceeded without any difficulties, the 10-in. casing having been set on a shoulder at 600 ft. below the ground and sealed at its junction with the 14-in. casing with a lead seal in order to keep the salt water out of the well, and at a distance of 950 ft. below the surface of the ground the 8-in. pipe was set on a good solid rock shoulder and then sealed to the 10-in. casing making a continuous and tight pipe to the shoulder. The wall at this point was a very close grained, dense limestone and there was no reason for any further casing.

Straightening the Drill Hole

At 1200 ft. below the surface of the ground the drills, for some reason not exactly understood, began to get out of the perpendicular line. This was probably caused by a projection over which the drills slid; at any rate it was found that there was a deflection of several inches from the perpendicular in the drill hole. The drills were withdrawn and 50 ft. of boulders and small pieces of cast iron were dumped into the hole, tamped down and drilled through again, thus straightening the hole, and no further trouble was encountered. At 1275 ft. the great timber walking beam split and this caused a delay of four days while a new one was being made. The cost of this incident was $100.

The fine grained limestone in this section, that is, between El. 1000 and 1400 ft., was found to yield about 60 gal. per min. of clear water of excellent taste. The salt water had been effectually cut off by the weight of the 8-in. casing resting on the rock shoulder.

At a depth of 1400 ft. the cast-iron saddle of the walking beam broke twice in succession, causing a week's delay. At 1445 ft. the St. Peter sandstone was encountered. About here the bottom 6 ft. of the drill broke off. It was recovered with slips operating at the end of the drill cable. At 1548 ft. a clay formation was encountered and the well declared finished. It was tested for capacity, and 300 gal. per min. for 13 hr. was pumped without exposing the well cylinder, which was set 250 ft. below the surface of the ground.

The contract price of the well complete was $6628, delivered to the city. The cost to the contractor on account of lost tools, etc., was about $1100. The mine cost (concreting, cleaning entry, etc.) was $460. The cost to the city for use of the rush order pumping machinery was about $275. The contractor under the specifications must stand this entire expense, but the city did not force him to pay for the extra pumping equipment.

The contractor, H. H. Adkins, of Sullivan, Ind., worked hard and faithfully, and, though lacking somewhat in necessary equipment, handled his work very skillfully. The writer was consulting engineer for the city of Oglesby.

Reinforced-Concrete Flagpole at Panama

By G. C. Dobson*

A reinforced-concrete flagpole erected on Administration Hill at Balboa Heights, Canal Zone, presents a unique piece of construction. It stands on the principal axis of the Administration Building and 59 ft. in front of it. Its position at the head of a spacious flight of steps from the terrace to the main townsite gives it added prominence.

The pole has a clear height of 70 ft., a ground penetration of 12 ft. and rests on natural soil. It is sixteen-sided

*Assistant Engineer, Permanent Building Division, Panama Canal.

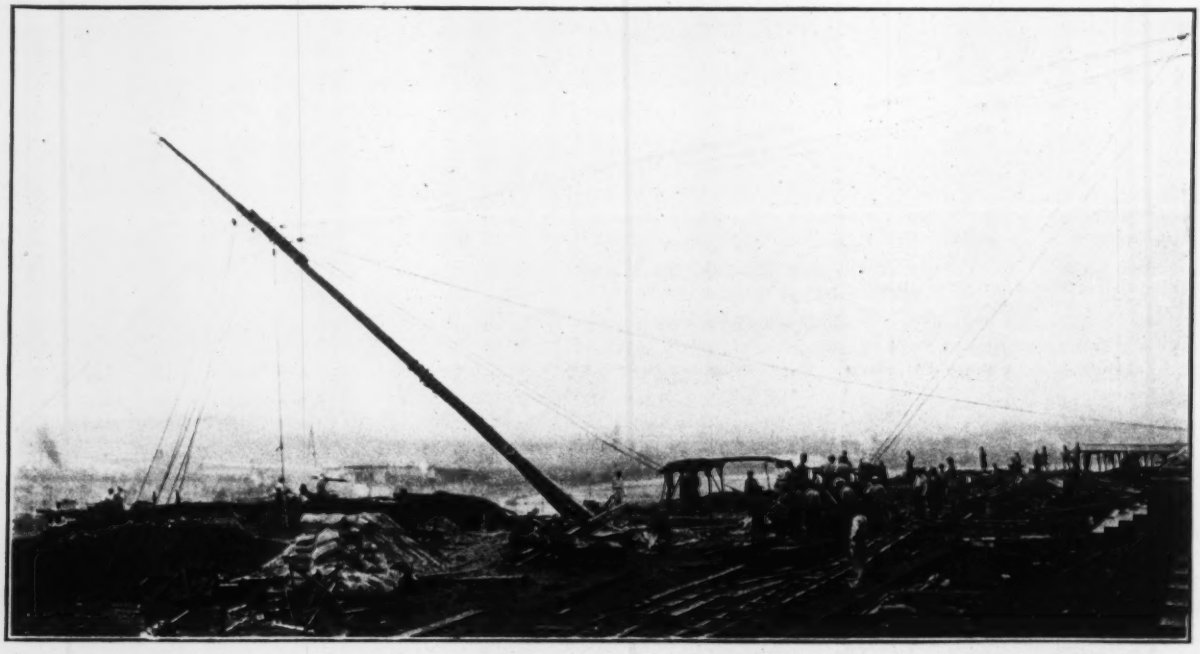


FIG. 1. RAISING THE REINFORCED-CONCRETE FLAGPOLE IN FRONT OF ADMINISTRATION BUILDING

and has a diameter of 8½ in. at the top and 17 in. where it joins the ornamental base. It is reinforced longitudinally by eight square bars, which are 1½ in. in thickness at the base, graduate down to ¾ in. at the top, and

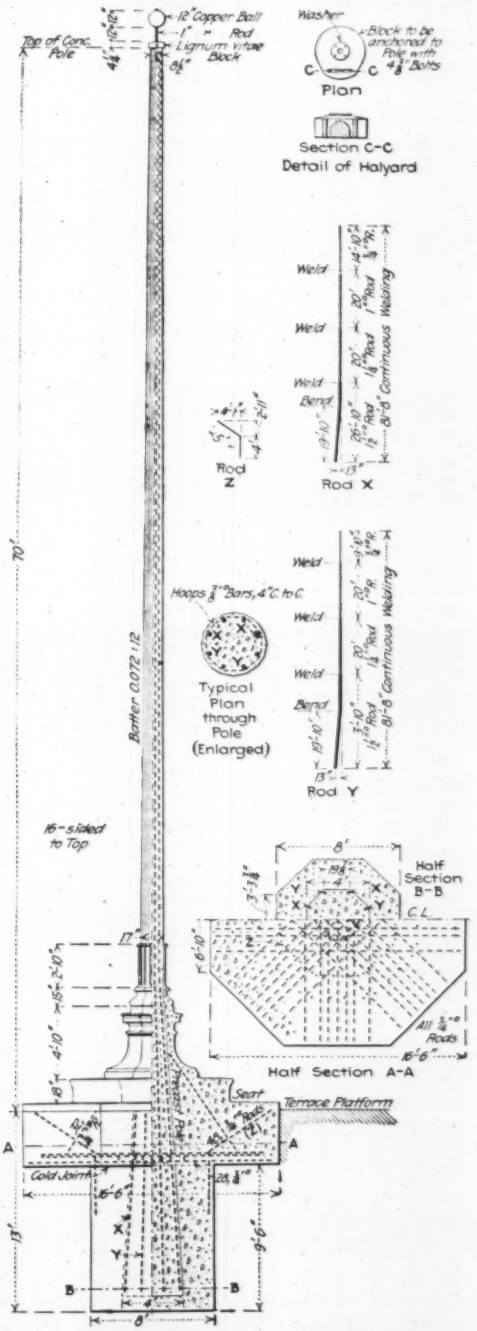


FIG. 2. DESIGN OF REINFORCED-CONCRETE FLAGPOLE AT PANAMA CANAL

are welded so as to form continuous bars. The welds are reinforced and staggered. The pole is also reinforced by hoops of ⅜-in. square bars spaced every 4 in.

The pole was precast in position for erection in wood forms, which had to be constantly adjusted to keep the pole in alignment, due to the settling of the fill on which the forms were set up and to blasting in the neighborhood. The concrete was a 1 : 1 : 2 mixture. Eighteen days after pouring it was erected. Stresses were developed during erection much greater than would be caused by a hurricane of 100 mi. per hr.

The lower 10 ft. of the pole consists of a spreading octagonal base of flutes and plain moldings, with a seat and platform at the bottom. These members were all precast and set up after the pole was erected. They are about 3 in. thick and heavily reinforced with mesh. The pole itself received a thin coat of stucco after erection to true up the arrises and to remove all form marks.

To the top of the pole is secured a very heavy cast-brass pulleyless block, through a groove in which slides the flag halyard, and through the center a 1-in. brass rod projects 1 ft., carrying a 12-in. copper ball, double gold leafed. The center of this ball is about 167 ft. above sea level. At the base the halyard passes through the cap molding and is secured to a cast-brass cleat directly below it.

The method of erection is shown very clearly in the accompanying photograph. Two electric winches were employed.

The pole was designed and erected by the Permanent Building Division, Supply Department, Panama Canal. The erection was done under the direct supervision of the Division Engineer, Frank Holmes. The architectural design was handled by S. M. Hitt, Architect of the Panama Canal, and the engineering design by the writer.

An Automatic Speed-Control and Train-Stop System has been given a trial on the Chicago, Burlington & Quincy R.R. The installation covers 6 mi. of single track, with several track contacts or block stations for movements in both directions. The special feature is the control of train speed by "Caution" indications and the application of the brakes by "Stop" indications. The contact rail is normally energized and causes a lamp to be lighted in the cab, indicating that the engine has entered the block section. The engineman presses a button, by which the lamp is extinguished and a record made of his action. In starting from a terminal, only a limited (and prescribed) speed can be attained, and a whistle in the cab sounds until the engine passes a contact point at "Clear," after which the engineman has full control of the speed. For a "Caution" indication, the contact rail is partly energized, and causes the train-control apparatus to reduce the speed to the prescribed limit. It also causes the cab whistle to sound continuously. If the indicator at the next contact point is "Clear," the train-control will be made inoperative, but if the indication is "Stop," the brakes will be applied and another whistle sounded. In order to proceed, the engineman must unlock and open a box and set the apparatus for the slow-speed condition. He cannot set it for full speed, this being done only automatically when the engine shoe strikes an energized contact rail. The opening and closing of the box and the setting of the apparatus are all registered, so that all the actions of the engineman are on record. This system has been installed by the Gollos Railway Signal Co., 76 W. Monroe St., Chicago. Hiram J. Slifer, Rookery Building, Chicago, is consulting engineer for the company.

Difference Between Investment and Value of a small public-utility property is illustrated by the recent appraisal case of the District of Columbia Public Utilities Commission in re Washington & Maryland Ry. Co. This company operates a short, struggling electric railway extending out from the outskirts of Washington. The amount expended in construction and equipment as shown by the records was $119,558, while the reproduction of cost was $67,047, and the reproduction cost less depreciation was $61,381. In determining cost of reproduction 5 per cent. was allowed for engineering and superintendence, 3 per cent. for interest during construction and 3 per cent. for the legal, organization and insurance items, omissions and contingencies. Many of the original investments were wasted expenditures. Some parts of the installation were abandoned after a short time; others were not in service for considerable periods and were not well maintained. Most of the plant now actually used and useful has recently been built or rebuilt.

Three-Mile Approach Viaduct, St. Louis Municipal Bridge

A total length of 16,300 ft. and a steel weight of about 23,000 tons characterize the viaduct[1] which forms the east approach of the St. Louis municipal bridge over the Mississippi. Its size makes it one of the most important pieces of viaduct construction in this country. About two-thirds of the length of the structure is railway viaduct and about one-third highway viaduct, the two being of different types.

Features of the design are: Simplicity of the general arrangement; extensive uniformity and duplication without sacrifice of economy; the use of the main girders as track stringers in the highway floor, saving both in stringers and in floor-beams; and provision for expansion in every intermediate span.

The footings of the viaduct columns are on piles. The concrete piers extend about 15 ft. above ground, to get above flood level.

General Arrangement

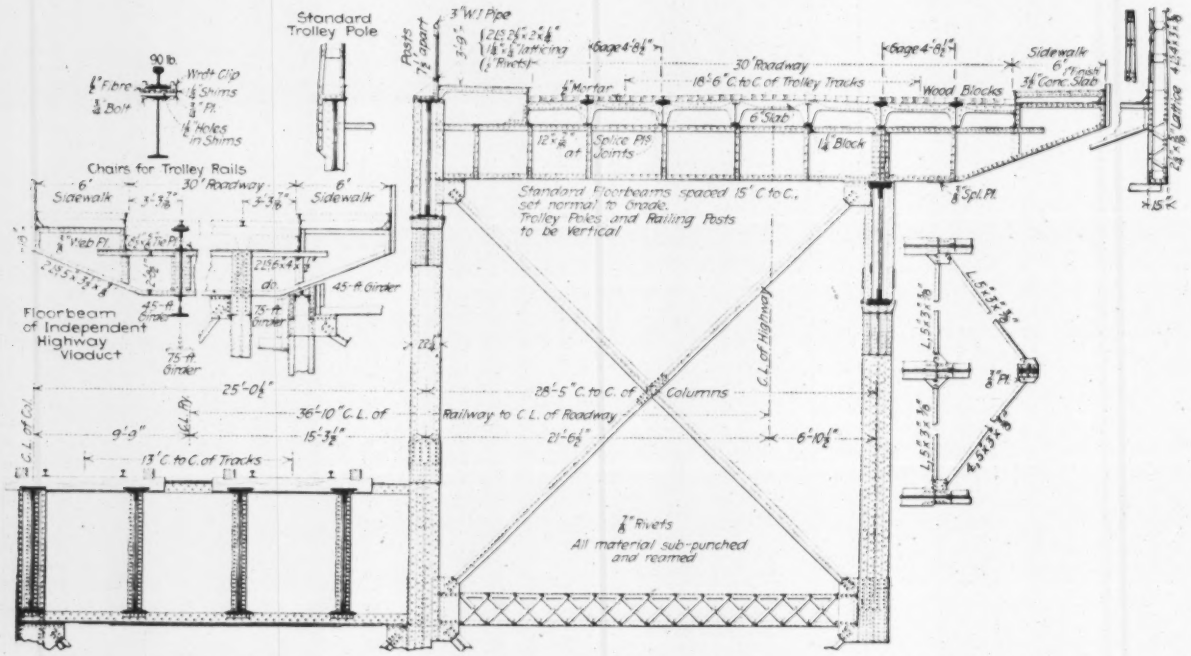
The approach passes almost directly eastward from the east end of the river bridge, crossing over all the railways in the east bottoms. The length of viaduct from the bridge to the east end of the approach is 13,300 ft. The first 2300 ft. is combined highway and railway viaduct, and at its end the highway viaduct diverges northeastward, extending 3000 ft. to Tenth and Pickett Ave., East St. Louis, while the railway viaduct continues east for 11,000 ft.

The design includes provision for two future turnout viaducts for railway connections—(1) a turnout to the northward, starting near the river bridge, for connection with the Pennsylvania R.R. tracks, and (2) a turnout to the south starting at the point where the main railway and highway viaducts diverge, for connection with the Illinois Central R.R. These are not being built at the present time.

The gradients of the approach are 2.015% on the highway structure and 0.128 to 0.983% on the railway structure.

The drawing herewith shows the combined portion. The separate railway viaduct in its arrangement of parts is identical with the railway half of the combined viaduct. The separate highway viaduct differs from the highway half of the combined structure in having its roadway centered over the columns and its longitudinal girders raised up so that the floor-beams connect to their webs.

The determining feature of the arrangement is the 15-ft. floor panel of the highway viaduct, which was maintained uniform throughout the structure (except for a few end panels of slightly different length). This panel-length permits of using rolled I-beams as stringers with considerable economy. The panel length determined the spans as multiples of 15 ft. The columns being braced in sets of four as towers, according to regular viaduct practice, the normal spans adopted are 45 ft. for the towers and 75 ft. for the intermediates.



CROSS-SECTION OF EAST APPROACH VIADUCT TO ST. LOUIS MUNICIPAL BRIDGE

Highway Viaduct

The street-railway tracks are set close to the curb of the 30-ft. roadway, leaving a single wagonway in the center, large enough to accommodate two lines of vehicles. The position of the tracks is such that the main longitudinal girders serve as outer-track stringers. The floor is a 6-in. reinforced-concrete slab carrying creosoted-wood blocks on a mortar bed. The track rails are ordinary T-rails, laid on shim plates (to make up for the varying thickness of the girder flange plates) capped with a ½-in. sheet of hard fiber to decrease noise and vibration.

In the independent highway viaduct, where the 32-in. floor-beams frame into the webs of the girders, the webs are slotted to pass a top flange tie strip for supporting the sidewalk cantilever bracket. In the combined highway

[1]Contract for the steelwork was let to the American Bridge Co. July 9, 1915, as noted in "Engineering News," July 15.

and railway section, the highway floor-beams are shifted toward the free side in such a way as to give approximately equal loading on the two columns.

Railway Viaduct

The railway viaduct, double-track throughout, has the same normal span lengths as the highway portion—45 ft. and 75 ft. The tower bracing in transverse planes is in a single panel; but although the greatest height of the viaduct is 71 ft., the structure is wide enough to give the diagonals a satisfactory slope.

Expansion is provided for in each 75-ft. span. The railway stringers of these spans are deeper than those of the tower spans, but near the expansion end the lower flange of the intermediate span is curved upward in ogee form to the level of the bottom flange of the tower-span girder, which gives sufficient depth for the expansion pocket. The riveting of girders and stringers to the floor-beams is the same at expansion points as at fixed points, so that no difference in the floor-beam web punching is required.

The design for the viaduct was made by Boller, Hodge & Baird, 145 Broadway, New York City, consulting engineers to the city of St. Louis for the municipal bridge. The estimated cost of the east approach, including real estate, is $2,750,000. The present contract covers only the fabrication of the steel, the price being in the neighborhood of $43 per ton delivered.

Aqueduct Outlet Cascades

By Burt A. Heinly*

The "cascades" of the Los Angeles aqueduct are at the outlet of the last tunnel on the aqueduct, 27 mi. northwest of Los Angeles. Emerging from the tunnel portal the full 20,000 miner's-inch flow of the aqueduct, in a stretch

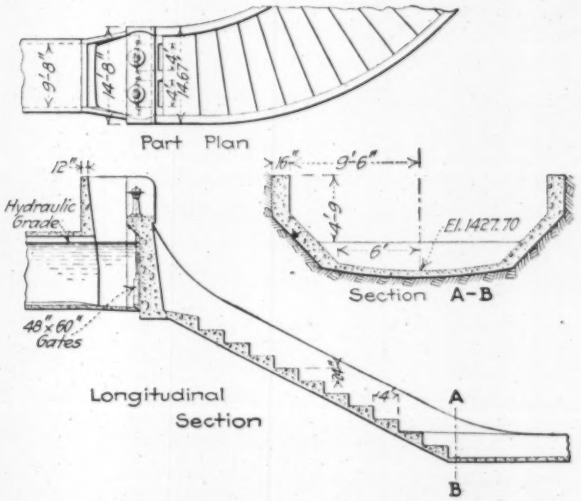


FIG. 1. DETAIL OF TUNNEL PORTAL AND STEPPED PORTION OF CASCADES

of 1037 ft. of rock-embedded masonry conduit, descends a distance of 167 ft. and produces the effect of a natural cascade.

The purpose of the structure is chiefly æsthetic although it has a high practical value in its thorough aëration of the water. Ultimately, however, it will be eliminated, as the total fall of 294 ft. from the outlet of the aqueduct to the high-water elevation of the prospective upper San Fernando Reservoir makes possible a hydro-electric development of 9685 hp.

A problem of design was to adapt the structure to the natural surroundings, within a 75-ft. right-of-way, simulating in concrete, so far as possible, a natural water course. The terminal tunnel has a height of 10½ ft. and a width of 9⅔ ft., with a flat slope of 2⅛ ft. to the mile, the exit opening from the precipitous slope of the range onto a spur or hogback.

Following the construction of a permanent road up the east side of the hogback, the face of the cliff from which the tunnel emerges was cut back 20 ft. to a hard con-

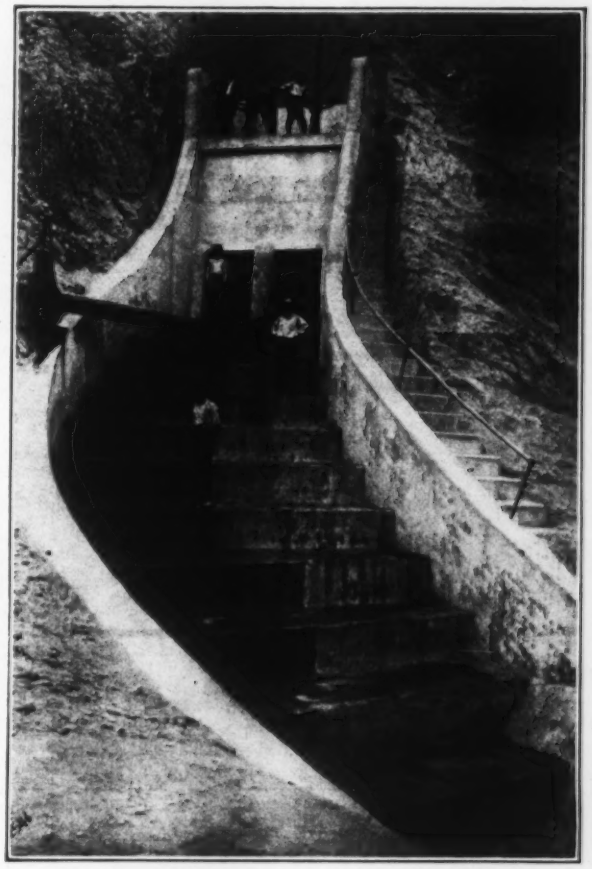


FIG. 2. TUNNEL PORTAL AND CASCADES HEAD

glomerate and a bulkhead of concrete built 3 ft. wide at the base to 2 ft. wide at the top with an overhang for the gate stands. The bulkhead was raised to a height of 13½ ft. above the floor of the tunnel. (See Figs. 1 and 2.) Besides containing two portholes (not shown in Figs. 1 and 2) 1 ft. high by 4 ft. wide, set 1 ft. below hydraulic grade, the bulkhead is 5 ft. forward from the mouth of the tunnel in order to provide for a safety overflow to relieve the pressure should the gates in the bulkhead ever be closed when the aqueduct is under flow. In the bulkhead are set two cast-steel sluice gates, 4 ft. high by 5 ft. wide, with bronze bearings, lifted by a 2¼-in. screw and operated by hand.

The first drop of 22 ft. in a distance of 49 ft. was taken care of by benching off the foundation in a series of 11 steps, each of 2 ft. rise., 4 ft. tread and ranging in length from 12 ft. at the top to 19 ft. at the bottom. The side walls to prevent overflow rise vertically 4½ ft. above

*645 South Olive St., Los Angeles, Calif.

the floor of the step and are of concrete, 16 in. thick, of 5½ parts of washed gravel to 1 part of Monolith cement. This cement—which was manufactured by the municipal cement mill and which as a municipal product was subjected to much criticism from certain quarters—was used throughout in the building of the "cascades." After being for more than a year subjected to flows under a very high velocity, it shows no signs of the wear or disintegration so freely prophesied.

From the foot of the stairs to the bottom of the cascade, the canal or conduit varies from 19 ft. in width and 4 ft. in depth to 72 ft. wide and 6 ft. in depth. This height at the bottom was made necessary to connect with the open-lined conduit at the foot of the cascade.

The grade for the 19 ft. of steps is 50 per cent.; for the next 750 ft. the canal varies in width from 19 to 37½ ft., with a grade of from 1.4 to 24 per cent.; for the remaining distance of 220 ft. the canal is from 37½ ft. to 72 ft. wide and has a grade of 30 per cent. On this last section the boulders were strewn as shown in Fig. 3. Considerable difficulty was experienced in the matter of elevation and location necessary to give the spectacular effect of a mountain torrent that was desired. The result is shown by Fig. 4. A total of 60 cu.yd. of boulders was required. These were selected to run about 1 ft. in diameter and were placed about 1 ft. apart. They were dropped into the concrete after it had been shoveled so that there was at least 1 in. of concrete between the base of the boulders and the subgrade. The concrete was then trowelled down. This left from 4 to 6 in. of the boulders protruding.

At the foot of the cascade, intersection is made with the open-lined conduit at an angle of 63 deg. Here almost all of the momentum and agitation of the water is taken up in a distance of 75 ft., the water entering the straight-away of the conduit as a smooth-flowing stream. Because of the great range of velocities in this open-lined conduit, in its length of 7975 ft., considerable allowance for difference in velocity-head had to be made. This was done without noticeable drop in the conduit by making long transitions in which the allowance for the difference in velocity-head in addition to the flow-grade was distributed along the transitions. In this way allowances of from 1 to 3 ft. difference in velocity-head are made which are unnoticeable to the ordinary eye.

FIG. 3. VIEW OF LOS ANGELES AQUEDUCT CASCADES BEFORE WATER WAS ADMITTED

The work was carried on under the direction of William Mulholland, chief engineer; E. A. Bayley, field engineer, and Henry L. Jacques, construction superintendent.

Unusual Activity in Canadian Power Development

The water-power industry in eastern Canada presents almost the only evidence of engineering and construction activity throughout the Dominion, where large building construction is generally halted. In Toronto a $3,000,000 union railway-terminal project, for which contracts were let, has been shut down (though disagreement among the interested railroads may be largely responsible), and the harbor development is not progressing as fast as had been anticipated.

In Montreal there is nothing new of size being undertaken except a $400,000 extension to grain elevator No. 1. Old works like the Sun Life building and the Canadian

Northern Ry.'s Mount Royal tunnel and terminal are going ahead rather slowly.

The construction being done stands out by its comparative isolation. In Quebec the union railway station, a $300,000 project, has been started and some steel is being put up; a large addition to the post office is being made and there is some river improvement. The Province of Quebec is taking advantage of the low cost of labor to build some 60 steel highway bridges, one of $150,000 cost; tenders on the work after the war began showed a decrease in cost from those before of from 15 to 20%. Railway activity seems confined to Government trans-continental lines and the great Quebec bridge, on which steady progress is seen. In Halifax the large railway and harbor development scheme, aggregating in cost possibly $1,000,000, is now well under way. The Welland Ship Canal enlargement around Niagara Falls is being prosecuted with some vigor. Both of these projects have been described in recent issues of *Engineering News*.

In view of the general depression, the increasing activity of the water-power companies is striking. Contracts have been let for $1,500,000 of work on the upper St. Maurice River storage and flow-regulation scheme. This will be one of the largest conservation developments on the continent, benefiting such large power concerns as the Laurentide and Shawinigan companies. A company known as the St. Maurice Construction Co. has been organized to carry on this work, the Shawinigan Power & Water Co. and Fraser, Brace & Co. (builders of the great Cedars Rapids development) being largely interested.

Construction work on the huge Laurentide hydro-electric station at Grand Mere, which ceased on the outbreak of war, has been resumed. The Shawinigan company has acquired the old Dorchester light and power company in Quebec, taking advantage of the financial difficulties of the latter, and will immediately run a 90-mile transmission line to Quebec.

The Quebec Streams Commission is asking for tenders on a $100,000 project on the upper St. Francis River. This is a storage and flow regulation project similar to that on the St. Maurice. Pulp mills will be the chief beneficiaries.

It is generally expected that construction work on the 500,000-hp. hydro-electric project on the Saguenay River above Quebec, backed by the Duke interests from the United States (Southern Power Co.), is about to be started, though no official information is obtainable. The preliminary work seems to be progressing, however. This development involves building a new town, at an anticipated expenditure of $5,000,000 or more, for the fertilizer and other electro-chemical industries here.

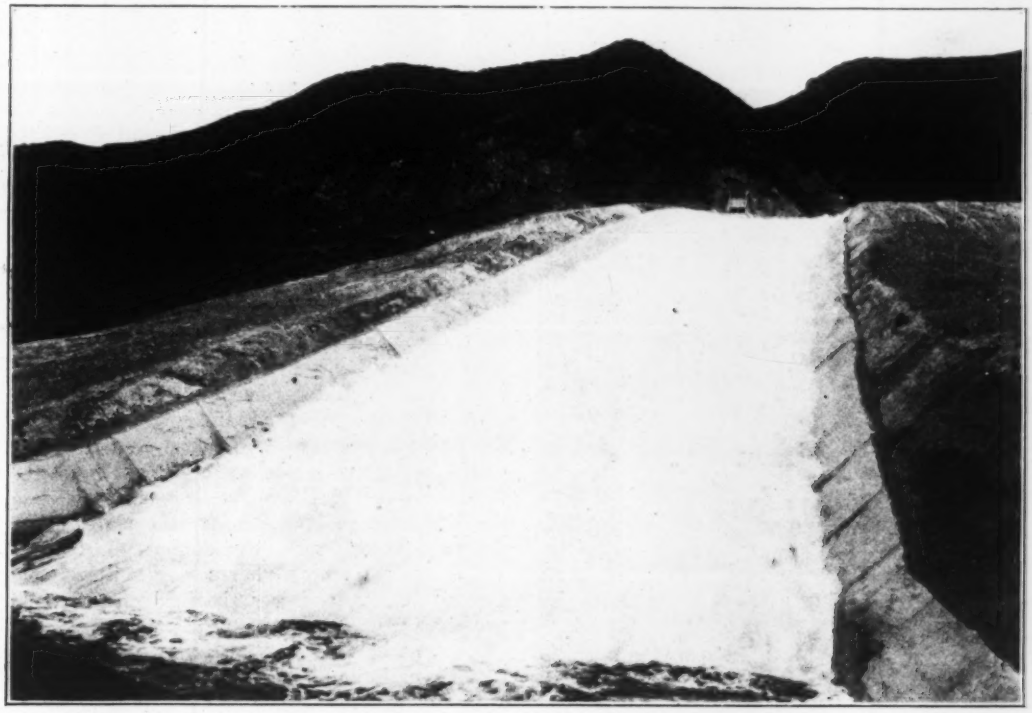


FIG. 4. EFFECT PRODUCED BY BOULDERS IN OUTLET TO LOS ANGELES AQUEDUCT TUNNEL

Part of the improvement in the power situation is probably in consequence of the manufacture of war materials. A great deal of it can be traced to the aluminum industry. The French and Scandinavian supplies are shut off and a great increase in the demands on American works has been felt. A small part of the aluminum demand is for military goods, like water bottles, motor-car and aëroplane parts, etc., but the greater portion is for the usual commercial purposes.

Owing largely to the demands of the aluminum works at Messina, N. Y., which take 60,000 hp. from the great Cedars Rapids plant near Montreal (described in *Engineering News* of Mar. 25, 1915, p. 566) the load on this station has jumped up to nearly full figure, though the station has been running only about eight months. Consequently extensions originally projected for construction several years from now will probably be made much sooner.

Field and Office

Drainage and Foundations on the Maine Post Road

The first state highway work undertaken in Maine, under the $2,000,000 appropriation made by the 1913 legislature, has been the building of a 21-mi. bituminous-macadam road from Portland to Brunswick. The contract for this entire work was let in 1914 to R. F. Hudson, Melrose, Mass.

On the first 6½ mi. of road out of Portland, an examination of the soil conditions during the spring of the year showed the necessity of special foundation and drainage treatment. There was a great scarcity of stone for filling subdrains, and it was decided to use a V-type gravel drain 30 in. deep in the center and a 4-in. tile drain with side outlets, in the bottom, where stone could not be

DRAIN TILE IN V-SHAPED GRAVEL TRENCH, MAINE POST ROAD

obtained. Of the whole distance of 6.63 mi., 1.33 mi. (20%) was built with a V-shaped gravel ditch and tile drain, 0.46 mi. (7%) with V-shaped ditch and stone drain, 0.67 mi. (10%) with an 8-in. stone base, and 1.36 mi. (20%) with a 4-in. gravel foundation.

A case of underdrainage was encountered just beyond the second mile, for about 100 ft., where it was necessary to resort to a combination of special stone drain and tile drain. The stone foundation was made 24 in. deep at the sides of the road and 30 in. at the center, while in the center and at a depth of 4 ft., a 4-in. tile drain was placed with side outlets of tile at intervals of 25 ft. This was found effectively to remove a bothersome and long-feared "honey-pot" of large area.

The highway work in Maine is in charge of a commission of three members, for whom Paul D. Sargent, former Assistant Director of the United States Office of Public Roads, is Chief Engineer.—William J. Dougherty, Portland, Maine.

Central Plant for Concreting Over Large Area

By F. L. Shea*

The concrete footings and basement wall and piers of the recently built Circle Building, New York City, were poured from a central plant, the layout of which is shown in the accompanying sketch and view. The shed sheathed with tar paper, as shown in the view, is for cement storage. The bin to the right of the tower in the same photograph is for gravel (500 cu.yd. capacity), and the one behind the tower is for sand (280 cu.yd. capacity).

The charging hopper of the mixer is on a level with the platform of the sand and gravel bins. Directly above this hopper and extending to the level of the floor of the cement storage house is a hopper lined with galvanized iron, into which the cement is discharged. When the bins were full the sand and gravel were shoveled to the mixer hopper; when material in the bins was level with the platform or below it, the sand and gravel were wheelbarrowed to the hopper. To avoid this operation the bins were kept filled above the platform level until the work no longer required storage.

The cement storage house was built of tongue-and-grooved boards, and was sheathed on the outside with two-ply tar felt, well lapped and secured with wood battens. The roof was covered with felt secured with roofer's nails and disks. To prevent the cement from coming in contact with rain-water running down the back wall and seeping in at the joints of felt and sheathing, a V-shaped gutter was provided at the rear and lined with felt.

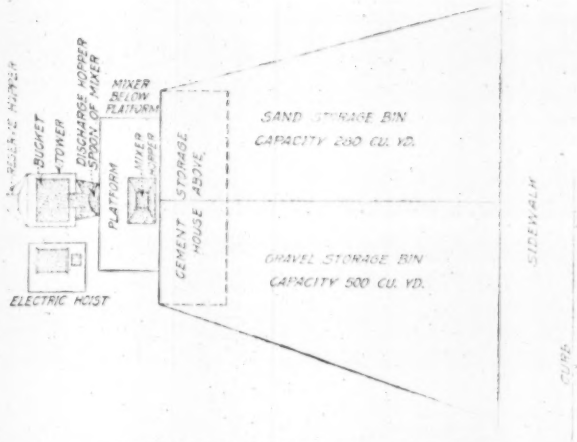
The trucking of material was done with a view to avoiding unnecessary handling. The top of the bins was level with the sidewalk and the sand bin was planked over to permit driving over and dumping directly into it through trap doors. The gravel bin was not covered, material was discharged into it from the top of the sand bin. The floor of the cement house was on a level with the truck platform, so that the cement could be unloaded from trucks into the house. The rear of the cement house opened on to the cement hopper.

The ¾-yd. bucket in the tower could be lowered into a pit 5 ft. below ground level, and the spoon of the discharge of the mixer was but 2 ft. above ground. This spoon delivered into a wooden hopper holding a ¾-yd. batch, so that while one batch was being mixed another was being discharged from this reserve hopper to the bucket and a third was being fed into the hopper of the

*Superintendent of Construction, Columbus Circle Construction Corporation, 2 Columbus Circle, New York City.

mixer—three batches moving at one time. The bucket was hauled up to the level of the chute hopper by the electric hoist, and was automatically tripped.

The reserve hopper was provided with a pin-hung discharge chute, which was operated by the bucket. As the



LAYOUT OF CONCRETING PLANT AT SITE OF CIRCLE BUILDING

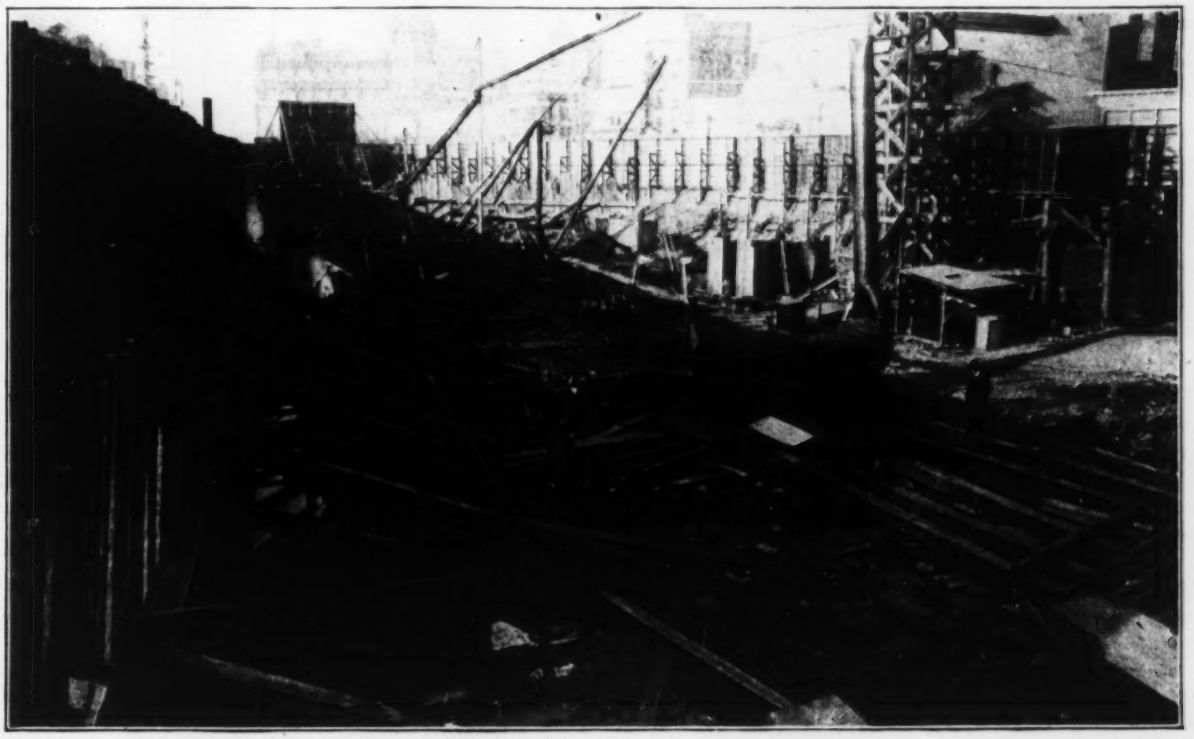
bucket ascended in the tower it turned this chute up and held the concrete in the reserve hopper, and when the bucket descended and passed the end of the chute it pulled it down and allowed the bucket to be filled. Later on, as the work progressed, the reserve hopper was abandoned and the concrete was fed direct from mixer to bucket by means of a galvanized-iron pipe slide chute.

It was found that the drippings from the reserve hopper settled in the pit at the bottom of the tower and interfered with the proper operation of the bucket. When the latter was discharging at the rate of a batch a minute this accumulation necessitated stopping the mixing and discharging at least three times in eight working hours in order to clean the pit. This cleaning operation took from five to eight minutes, which offset to a large extent the time saved by having a reserve batch.

A second reserve hopper was secured to the base of the tower, adapted to be filled by a length of chute to receive wheelbarrow loads. The purpose of this second hopper was to provide concrete for filling the minor pier holes while the chute was being shifted.

The chutes were in 30-ft. sections, the intersections being supported by ginpoles. This method was considered to be more satisfactory than using A-frames, as is ordinarily done. It permitted easy handling of the chute sections and shifting without disconnecting. The steel A-frame bracket which supports the first or tower chute was fixed in position so that the chute would be held permanently at the 65-ft. elevation during the entire course of the concreting. This elevation was maintained even when the concreting was at a point very close to the tower, making the descent of the concrete rapid. The chuting distance varied up to 200 ft.

Expense-Money Advances to Assistant Engineers—An engineer in New York City with a number of assistants who spend more or less time traveling has adopted the following means for keeping them supplied with expense money: To each assistant is advanced $50, for which he gives his note. At the end of each week the assistant puts in his expense account for the week. On the following Monday morning a check is given him for the account as approved, thus restoring and maintaining his $50 advance. This practice obviates what is a sore point with a large number of engineering and other employees throughout the country who are called upon to advance out of their own funds money for traveling and other expenses. Of course in some cases $50 would be an insufficient advance, but it serves to illustrate the principle. It may be added that one case has been reported to us in which a young man in the Federal employ was obliged to advance $600 personally for expenses before he got any of the money back.



GENERAL VIEW OF PLANT AND SITE SURROUNDED BY FOUNDATION-WALL FORMS

Engineering Work Preliminary to Pavement Construction

The engineering work preliminary to pavement construction or renewal varies in different cities. Generally a center line survey with cross-sections every 25 or 50 ft., with specifications, is about all the information given the contractor to bid on. A great many details are usually left to be decided by the supervising engineer, who is often called upon to do considerable supplementary survey work, such as giving lines, grades, etc. More often than in other branches of engineering work, the details of design, except at complicated side-hill crossings, are neglected.

Detail Survey and Design

In St. Louis, Mo., the Board of Public Service has organized a division of design—sewers and paving—one of the objects of which is to reduce to a minimum the engineering work required after the pavement construction has actually begun. The purpose is to furnish the contractor and supervising engineer with so much preliminary detail that there will be no call for survey or engineering work other than inspection and supervision, after the construction of the pavement has been started.

The payment for street-improvement work in St. Louis, both new construction and renewal, is by assessments on abutting property. Hence the first step is the preparation of a property map of the benefit district. For pavement work one third of the cost is assessed against the frontage on the improvement and two-thirds pro rata against the area within the benefit district, which usually extends half way to the next public street. For sewer work the assessment is by area. This map, of which Fig. 1 is a typical section, is compiled on a scale of 60 ft. = 1 in., chiefly from the record plans on file in the city. The original lot subdivisions are shown as well as their present division and ownership. Discrepancies in street lengths are adjusted if necessary after making the detail street survey, which is described in the following. While of considerable assistance to the contractor in making his estimates, the primary purpose of the detail plan is to facilitate the work of the construction or supervising engineer. A study of a section of a typical plan (Fig. 2) will show that the field engineer is relieved as far as practicable of all calculations, small details, etc., which would require office work on his part. This allows him to give his whole time to supervising the work of construction; and of course has made it possible greatly to reduce the field force, although it has correspondingly added to the designing staff. While the ultimate economy of the new method is not yet proved, very satisfactory results have been achieved thus far.

Preliminary to drafting the plan, a very complete survey of the street is made, and the corners of all intersecting streets and alleys are definitely fixed by reference to permanent structures or by setting monuments. All telegraph or telephone poles, lamp posts, fire hydrants, sprinkling hydrants or standpipes, valve boxes, sewer inlets, manholes, trees, curbs set on intersecting streets, street-railway tracks, sidewalks, and all else that probably will be affected or need adjusting in any way because of the new pavement construction are located and recorded in this preliminary survey.

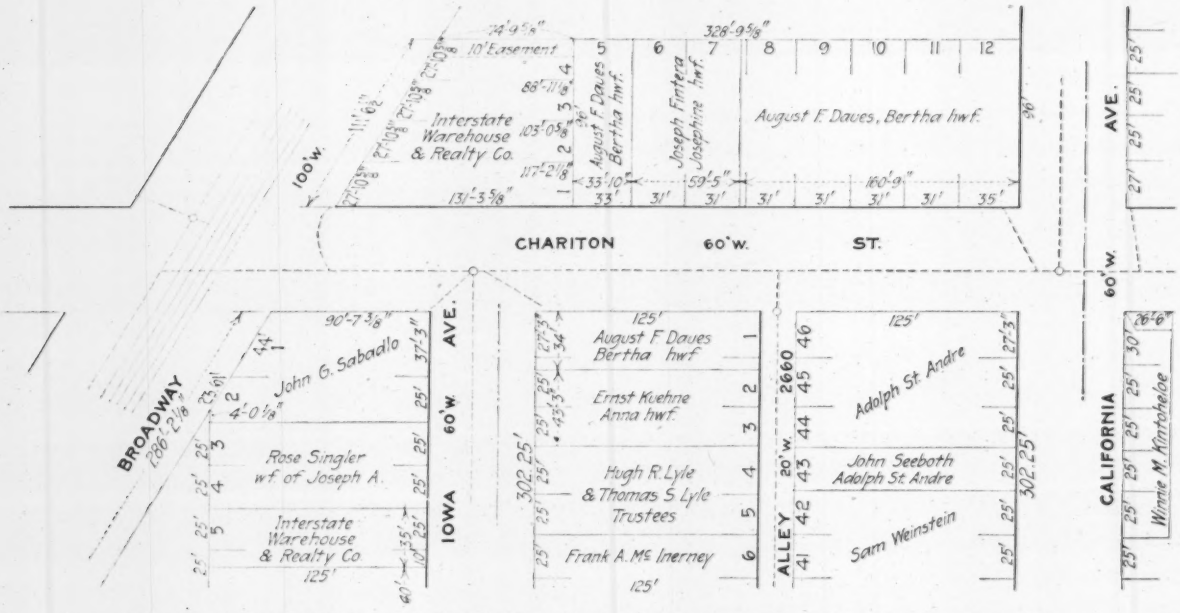


FIG. 1. ASSESSMENT MAP OF BENEFIT DISTRICT, PAVING IMPROVEMENTS, ST. LOUIS, MO.

With this information at hand the final details of the pavement design are worked out. The completed plan (Fig. 2) on a scale of 40 ft. = 1 in., contains all the record notes pertinent to the location of the street lines, the established grades, elevation of benchmarks, crown of pavement at various cross-sections, details of corners of intersecting streets, summaries of curbing required, inlets and manholes to be built, rebuilt or adjusted, water or gas mains to be lowered, pole lines to be adjusted, obstructions to be removed, and a preliminary estimate of the cost of construction.

This system of handling the pavement work, whether more economical in actual cost or not, has resulted in distributing the work of the engineering staff of the city

uniformly throughout the year, and gives an opportunity for greater accuracy, as well as furnishing valuable record plans of street conditions and changes.

Under the new city charter of St. Louis, the public works are controlled by a Board of Public Service, of

Cardboard templets have been used only for small pieces, such as gusset-plates. Long cardboard strips, as required for flange, angle and girder templets, are too troublesome to handle. The improvement introduced by H. B. Ash, of the Templet Co., consists of a new method

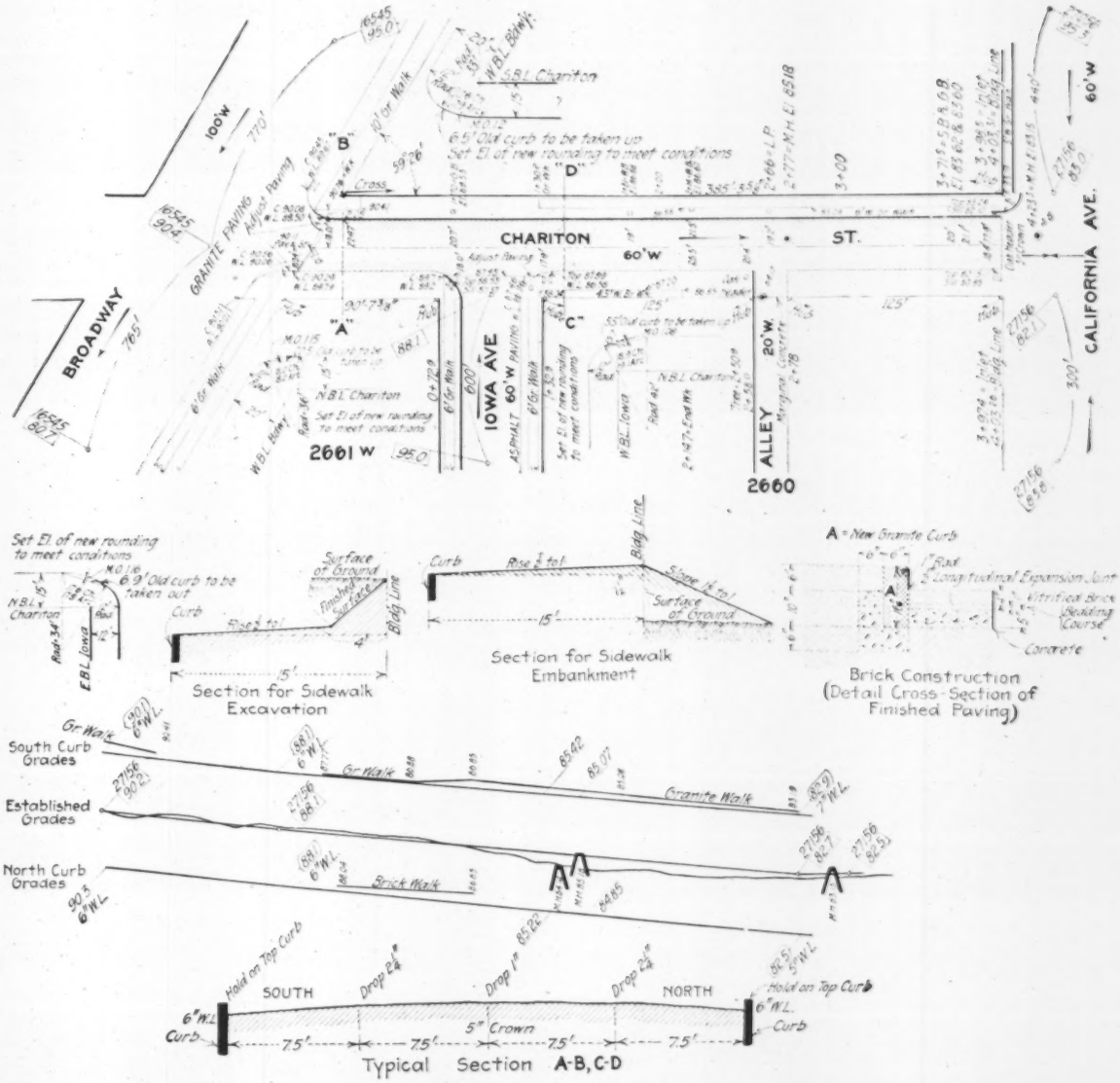


FIG. 2. PLAN, PROFILES AND CROSS-SECTIONS FOR PAVING IMPROVEMENT, ST. LOUIS, MO.

which E. R. Kinzey is President. The chief of the division of sewer and pavement design is W. W. Horner, and S. Sammelman is in direct charge of the paving section.

Cardboard Templets for Laying Out Structural Work

The practice of laying out rivet-holes in structural steelwork with the aid of wooden templets is pretty thoroughly established in this country. The Templet Co., of Ashtabula, Ohio, is making a promising attempt to change this practice by substituting cardboard for the more costly templet lumber.

of preparing, handling and applying cardboard for all lengths of templets.

Preparing and Handling

Experience has shown that cardboard expands and contracts, in consequence of moisture variations, about $\frac{1}{16}$ in. every 7½ ft. To eliminate this troublesome action the concern has developed a treatment by which the cardboard is finished with a sort of varnish gloss. It is claimed that this prevents all change of dimensions.

For girder web-plate templets, up to 8-ft. width and 30-ft. length, cardboard sheets of exact width are supplied by the company in rolls of 12-in. diameter, from which

the templet-maker simply cuts off the required lengths and at once proceeds to locate the rivet-holes.

For angle flange-plate and bar templets, one edge of a long, narrow piece of cardboard is inserted between a pair of maple clamping strips, which hold and stiffen it, and enable the cardboard to be handled conveniently in all lengths, besides serving as a guide in locating the holes. The clamping screws, spaced 18 in. apart, are so seated as to separate the clamping strips positively when the screw is turned in the release direction. Short pins in the jaw of the lower strip take hold of the cardboard and insure against its slipping. The strips may be made with a ⅛-in. scale marked on them to facilitate locating the holes; but on long lengths it is preferable to work with a steel tape. The width of the gripping jaws for holding the cardboard is ⅞ in., and cardboard for angle and flange templets is made regularly ⅞ in. over the even width; for example, 3⅞ in. wide for a 3-in. flange.

Applying the Templets

The templets are laid upon the iron to be marked in the same way as wood templets, with the advantage that the frame serves as a guide and rests upon the flange, and it is unnecessary to turn the iron to mark the opposite flange as is the case with a wooden templet.

The greatest saving with cardboard templets is in the templet-maker's time, as he is using a material which is more easily worked. On this point Mr. Ash gives the following figures:

Of a 15-ft. templet for a 6x6 angle, the total cost is about 35c. for wood and 17c. for cardboard. The saving of 18c. includes 15c. saving in cost of material (at $45 per M ft. for lumber and $8 per M lin.ft. for 6-in. cardboard), and 6 min. or 3c. saving in labor (elimination of sawing and trimming, while punching holes in cardboard can be done twice as fast as drilling them in wood).

For a 42-in. web-plate templet 15 ft. long the total costs are about $1.20 and 88c.; there is a 12c. saving in material cost and a 36-min. or 20c. saving in labor.

Handling Steel Centers for Concrete Arches

By Harold E. Ketchum*

The centering for the Detroit-Superior High Level Bridge was complicated by the number of different rises and spans of the arches. Arches 6, 7 and 8 have the same span and have been centered with similar three-hinged steel arches supported on steel columns (Fig. 1). Arches 2, 9 and 10 are shorter and are being centered by removing one section of the standard arch-truss and placing a new end post. Arches 1 and 5 will take the standard centering and arch 3 will have an extra section added to the trusses previously used. The remainder of the arches are being centered with timber except the arch over the Erie Railroad, which is provided with structural reinforcing strong enough to act as a support for the concrete.

At the crown of the steel centers a toggle adjustment provides a simple and satisfactory means of striking. It gives a clearance of 6 in. at the crown and about 1 in. at the haunches. The toggles are also used to bring the arches to proper grade before concreting.

The haunches of the trusses are pin-connected to cast-steel and structural-steel shoes having a wide base to roll on. Four-inch steel rollers in nests of five are placed under the shoes. Three 12x12 oak timbers protected by a ¼-in. steel plate and supported by sectional steel columns serve as a runway on which to move the centering.

Erecting the Centers

The steel trusses arrived on the job in sections on cars. The unloading and handling during the assembling were done by the cableways. All parts are bolted together (¾- and ⅞-in. bolts). A tower of 8x8-in. posts and 2x8-in. braces is placed to support a pair of half arches near the crown of one pair of trusses while the opposite trusses are erected and pins driven. Each truss weighs 12½ tons and while the rated capacity of the cableways is 8 tons there has been no difficulty in handling the heavier loads.

The cables of the cableways are located midway between each pair of ribs and the trusses had to be erected under the cables. When the two steel arches forming the centering for one concrete arch rib are erected, the end pins are connected with cables and turnbuckles. Enough tension is brought to bear on the cables with the turnbuckles to raise the centering off the tower. The centers are then jacked over into position, two 10-ton track jacks being used.

When the steelwork for both ribs is in position, cross-bracing is placed between the pairs of centers, and diagonals of the turnbuckle rods in the lower chord. When

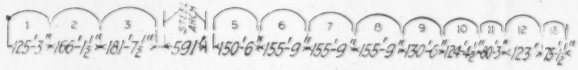


FIG. 1. DIAGRAM OF ARCHES, DETROIT-SUPERIOR BRIDGE

the trusses are braced together they make a stable unit, but as a matter of safety a ⅝-in. wire-rope guy is fastened on each side of the crown and secured to deadmen with turnbuckle connections for adjustment.

Upon striking the centers after having concreted one pair of ribs they are moved as a unit to the other side of the bridge into position for concreting the other pair of ribs. A hoisting engine and five-part blocks are used in moving. When the trusses have been struck for the last time they are rolled between the arch ribs and supported by turnbuckles hung from steel girders resting on the arch ribs, while the pins are driven out. The cableway is then used to remove the trusses.

The average time of erecting one complete set of centering for one rib is about 6 hr. To roll the trusses from one side of the bridge to the other, the distance traveled being about 46 ft., requires from 4 to 8 hr.

The Hunkin-Conkey Construction Co., of Cleveland, Ohio, is the contractor for this part of the bridge work.

*Superintendent, Hunkin-Conkey Construction Co., Cleveland, Ohio.

A Comparison of Railroad Wages in 1871 and **1914** is made in a bulletin issued by the New York, New Haven & Hartford R.R., as follows:

	1871	1914
Average monthly pay:		
Passenger engineers	$90 and $100	$131.39
Passenger firemen	50	75.35
Passenger conductors	100	133.73
Passenger brakemen	45 and 50	78.07
Freight engineers	$75, 85 and 90	177.51
Freight firemen	45 and 50	92.52
Freight conductors	85	118.88
Freight brakemen	45 and 50	82.10
Av. rate per pass., per mile	$0.02538	$0.01712
Decrease, 32.5 per cent.		
Av. rate per ton of freight, per mile	.04295	.01415
Decrease, 67 per cent.		

It is to be recalled that payments in 1871 were on a paper basis and not on a gold basis. Taking that into account, the increase in wage rates is even greater than the above table indicates.

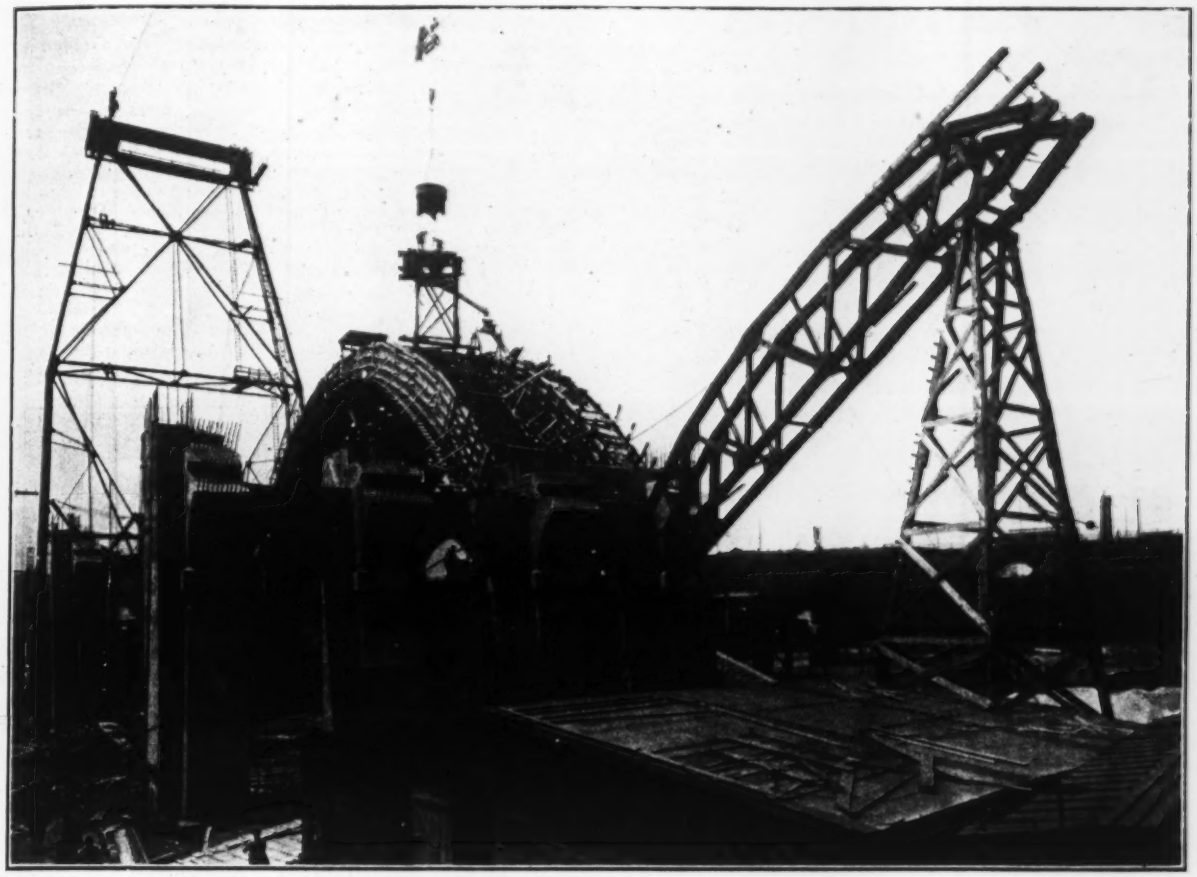


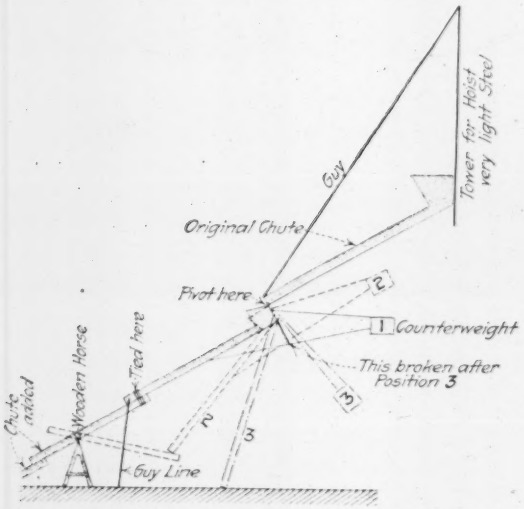
Fig. 2—Setting halves of the three-hinged arch centers on temporary tower

Fig. 3—Cableway placing last piece of centering for a pair of ribs

FIGS. 2 AND 3. ERECTING CENTERS FOR CONCRETE ARCHES OF THE DETROIT-SUPERIOR VIADUCT

NOTES

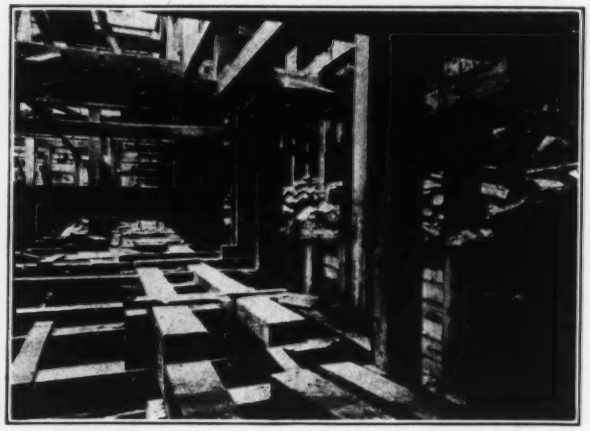
Neglected Turning Moments in the construction of a concrete distributing chute recently caused a Cleveland, Ohio, contractor considerable annoyance and expense. The manufacturer of the chute supplied a light skeleton steel tower with two lengths of chute, one attached to a carriage on the tower which could be elevated to suit the different floor levels the second pivoted to the end of the first length and balanced by a counterweight. These two lengths of chute, however, were not long enough to reach across the building,



COLLAPSE OF CONCRETING CHUTE FROM NEGLECT OF A LITTLE COMPUTATION

and the contractor added two lengths as shown by the full lines in the accompanying sketch, partly supported from the tower and partly by a wooden horse. The first batch of concrete wrecked the chute, for the counterweight was not sufficient to support the weight of the wet concrete when it ran into the first of the added lengths of chute. The structure assumed the position indicated by the dash lines marked 2. After hanging a few minutes in this position the counterweight arm commenced to bend, reducing its lever arm, the horse was pulled over and the chute and counterweight assumed the position marked 3. This accident resulted in about a 4-hr. delay in placing concrete and a lot of unnecessary labor, all of which might have been avoided by the use of some intelligence in supporting the chute.—A. D. Williams, Cleveland, Ohio.

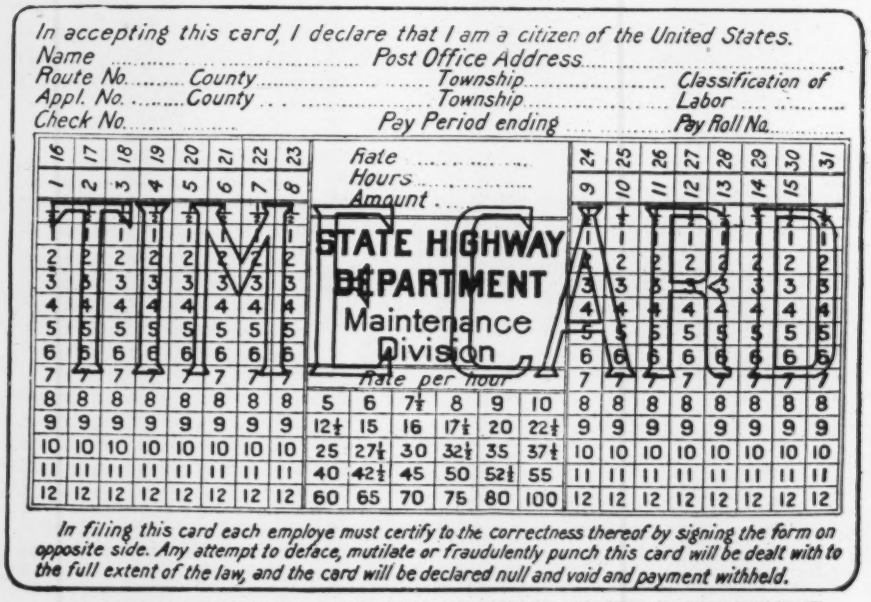
Use of Horizontal Sheeting in Subway Work—Horizontal sheeting has been used in a number of instances as the back form for concrete in the construction of the Flatbush Ave. subway, Brooklyn, N. Y. The soil is firm sand, clay and boulders. At one point where the excavation was very close to the building line, horizontal sheeting was placed all the way to the bottom of the cut, which was 30 ft. deep at this point. The timber sheeting was of the usual 2x8-in. size and was braced horizontally every 5 ft. In placing the sheeting it was guided and held by 6x10-in. vertical rangers or posts, which were driven down as the sheeting was placed. These rangers were spaced 5 ft. apart. In shallow cuts, such as where the six tracks are depressed, horizontal sheeting was placed and held every 5 ft. by two 6x12-in. bolted continuous cross-



HORIZONTAL SHEETING ALONG CUT FOR DEPRESSED TRACKS

braces or needles butting directly against 4x10-in. vertical rangers placed flat against the horizontal sheeting. The work is being done by the Cranford Co.

A Convenient Time Card is that shown in the accompanying illustration. It was devised to prevent dispute with the day laborers employed by the maintenance division of the Pennsylvania State Highway Department over the amount of pay due them from the state. The men are employed usually in small gangs, and each day the timekeeper or foreman punches the card for the date and number of hours worked. The rate of pay is also shown in a similar manner. The workman keeps his time card as a certified statement of the pay due until the semimonthly pay day, when it is surrendered and becomes a signed receipt for the files of highway department. For purposes of identification the workman makes a signed statement on the back of the card certifying to the correctness of the record. He also has a numbered brass check which he must show before cashing his time card. This time card does not replace the usual time-book record, but is supplementary to it, giving a check on the timekeeper's summaries. The time card must be approved and signed by the foreman before it becomes valid. This simple device has proved quite successful in use and has prevented many misunderstandings. George H. Biles, former Maintenance Engineer, now Second Deputy Commissioner of the Pennsylvania Highway Department, devised the system and card.


In accepting this card, I declare that I am a citizen of the United States.
Name ..... Post Office Address .....
Route No. ..... County ..... Township ..... Classification of
Appl. No. ..... County ..... Township ..... Labor .....
Check No. ..... Pay Period ending ..... Pay Roll No. .....
Rate .....
Hours .....
Amount .....
STATE HIGHWAY DEPARTMENT
Maintenance Division
Rate per hour
5 6 7½ 8 9 10
12½ 15 16 17½ 20 22½
25 27½ 30 32½ 35 37½
40 42½ 45 50 52½ 55
60 65 70 75 80 100
In filing this card each employe must certify to the correctness thereof by signing the form on opposite side. Any attempt to deface, mutilate or fraudulently punch this card will be dealt with to the full extent of the law, and the card will be declared null and void and payment withheld.

LABORERS' TIME CARD, PENNSYLVANIA STATE HIGHWAY DEPARTMENT

Editorials

Art in Water-Works Design

Few if any public works designed by the engineer afford such numerous and varied opportunities for artistic expression as those devoted to the water-supply of cities. That these opportunities were eagerly grasped and effectually improved in ancient, medieval and early modern times is shown by aqueducts, fountains and wells in various parts of the world.

With the advent of the thousands of water-works of the later modern type, made possible by pumping machinery, by iron, steel and improved forms of wood pipe, and by iron and steel standpipes and tower-tanks of the same materials or of wood, there came an era of water-works structures that needed no excuse for ugliness because they were buried or at most but rarely seen, on the one hand, and on the other, of structures whose inexcusable ugliness rose heavenward in the sight of thousands. Exceptions to these examples of quite unnecessary ugliness were occasional masonry-inclosed standpipes and tanks and here and there a pumping station which, either through sheer fitness for their purpose or else by chance, or again and more rarely through careful design, were pleasing to the eye.

The increasing demand for water storage on a large scale to keep pace with the enormous city growth of the last half century, has caused the erection of thousands of masonry dams, small and large, throughout the civilized world. Most of these dams have been designed in blissful ignorance of everything entering into what, for want of a better term, may be called architectural composition. As a rule, structures so designed are bound to fall short of their highest possibilities, yet many of them may nevertheless possess much artistic merit because of that sheer fitness of form to function which has already been mentioned.

How many times architects have been called in to aid in the design of dams would be interesting to know; as a guess, not many—at least not in this country.

Unquestionably the most notable attempt to treat a dam in accordance with architectural principles is the Kensico Dam, described in detail elsewhere in this issue. For reasons, methods and results, and much of value about the underlying principles of architectural design as applied to dams, the interested reader is referred to the article just mentioned.

Reverting now to tanks and towers, a class of water-works structures which are employed more to insure pressure than to provide storage, changes in purely structural design, such as curved for flat-bottomed steel tanks, and the growing use of reinforced concrete for standpipes and for elevated tanks, have in themselves wrought marvelous improvements in the looks of water tanks, towers and standpipes and have made further improvements easily possible.

One opportunity for art in water-works design there is which has gained considerable recognition but deserves far more. It comes through the heightening or, if need be, the creation of landscape and waterscape effects. An interesting example is afforded by the cascades of the Los Angeles Aqueduct, illustrated elsewhere in this issue. Landscape architecture, too, is a notable feature of the immediate surroundings of the Kensico Dam, already mentioned. Effective landscape work has also been done around some of the reservoirs of the Massachusetts Metropolitan Water District. To mention only one foreign example, nature and man have done nobly by the water-storage reservoirs of Leicester, England.

A typical example of lost opportunity which painfully impresses at least one person every time he passes by daylight over the horseshoe curve of the Pennsylvania R.R. is the bare and ugly embankments of the Altoona water-works reservoirs. A small expenditure there, under skillful direction, would at least ameliorate the blot on the landscape now caused by the dams, and perhaps bring these into harmony with the natural landscape and the pleasing effect of the water surfaces of the two reservoirs.

New England Water-Works Convention Attractions

An unusual program is offered by those responsible for the success of the annual convention of the New England Water-Works Association which is to be held in New York City, Sept. 7-9. For many years past the September conventions of this association have consisted of relatively few papers, an excursion or two and a considerable amount of open time. This year there are on the program 22 technical papers and addresses and one committee report, distributed through five sessions. In addition one afternoon will be devoted to an excursion by water and another to the Kensico Dam of the Board of Water-Supply of New York City—the architectural features of which are described elsewhere in this issue.

One reason for the unusually large number of papers this year is that the program includes two sessions for superintendents with six papers and discussions at each session. Another reason is that particular pains have been taken by the program committee to present to the visitors a number of interesting features of the design, construction and operation of the water-works of New York City. The range of subjects is almost as notable as the number of papers. And the subjects are live ones, too.

As may be judged from the foregoing statement, there is reason to anticipate a large and enthusiastic gathering of water-works men in New York City next week. The program offers instruction and entertainment a-plenty for each and all. The city in which the meeting is held has attractions of its own besides those in the water-works field which are so liberally represented on the program. Best of all in many respects will be the unlimited opportunities for quiet personal exchanges of water-works and other experiences and for the enjoyment of the good fellowship that prevails at all the water-works conventions, of whatever name and in whatever place.

It hardly needs to be said in conclusion that the New England Water-Works Association is local only in name. Its membership is well distributed throughout the United States and Canada. Although there may continue to be, for a while longer, more than one water-works association in America, there is only one water-works fraternity and all its members will be welcome in New York next week.

The Unstable Earth Fill

It seems almost like rubbing it in to call attention just now to the defects in the design of the earth section of the Galveston Causeway. A careful examination of periodical literature does not show a single protest against the protected earth fill which joins the short concrete arch section to mainland and island, on both sides nearly a mile away. As far as the records go, this part of the design was considered as reliable as the long line of concrete arches on their wooden piles. Today, in the light of its so complete failure, the truth is quite obvious. No earth slope can long stand up under water overflow. Protection in the way of paving or revetment will put off the evil hour, but sooner or later the initial crack develops and through the opening so offered the final destruction is only a matter of time.

This fact is well-known to builders of earth dams and river levees. Doubtless it was appreciated by those responsible for the causeway, though its importance must have been outweighed by considerations of economy or by an unwarranted trust in the calmness of Galveston Bay. The integrity of the concrete sheetpiles which survived the terrific assault of the hurricane and the stability of the concrete arches testify to the workmanlike manner in which the structure was built. It seems a shame that the extra cost of a rock fill was not ventured or a permanent pile-and-girder design of some sort utilized. At least some effort could have been made to avoid that unprotected ballasted roadway which was undoubtedly the "Achilles heel" of the whole structure.

Truly, as the poet says, "Hindsight is better than foresight."

Contract With an Inducement for Economy

Some time ago this journal received from the chief engineer of a prominent Western railway an inquiry as to whether any form of percentage contract had ever been tried under which the contractor would receive the actual cost of the work plus a percentage which would be so graduated that he would have a strong financial inducement to make the cost as low as possible.

It has been learned that such a contract was framed for the construction of the Cambridge subway, which was built for the Boston Elevated Railway Co. by the contracting firm of Hugh Nawn, of Boston. The contract between the company and the contractor, according to information furnished by C. S. Sergeant, Vice-President of the company, contained the following provision for payments:

The contractor received in the first place the actual cost of the work plus 10% of such cost. Upon the final completion of the work, the total cost, including the 10% paid to the contractor, was ascertained and compared with the estimated cost as determined by the engineer of the company, provision being made, in case this estimate was unsatisfactory to the contractor, for revision by a board of referees of three engineers. If the total cost of the work exceeded the estimated cost, then one-fourth of this excess was deducted from the 10% to be paid the contractor. In case, however, the final cost of the work was less than the estimated cost, the contractor was entitled to receive one-fourth the amount saved.

In computing the cost of the work, the cost of machinery, tools and appliances purchased for and used upon the work was included, less the value of such machinery, etc., at the conclusion of the work, to be agreed upon between the contractor and the company. This did not include, however, the small tools and supplies used, the entire cost of which was charged to the work.

A general and well-founded objection to the carrying on of contract work on a percentage basis is that the contractor has no incentive to practice economy in the conduct of the work. On the contrary, the more costly it is the greater is his profit. The use of the percentage form of contract, therefore, is generally limited to firms of well-established reputation which are carrying on work for private corporations which are not bound by the legal restrictions governing most public work as to advertising the contract and letting it to the lowest bidder.

Under the plan described, however, there is no reason apparent why such a form of contract might not be made applicable to the carrying on of public work let by open bidding. Those bidding on such a contract would state in their bid the percentage they would accept in addition to the actual cost of carrying out the work according to specifications, provisions for deductions from, and additions to, that percentage being included according to the plan outlined or such other plans as might be deemed advisable under the local conditions.

Everglades Drainage Problems and Florida Rainfall

Anyone who witnessed the destruction wrought as the result of a rainstorm of less than 6 in. at Erie, Penn., as reported in detail in *Engineering News*, of Aug. 12, can form some idea of what an inundation must result from a rainfall of over 15 in. in 24 hr., reported at St. Petersburg, Fla., on page 428 of last week's issue. The Florida storm, however, fell in a comparatively level country. St. Petersburg is on the Gulf Coast, with no opportunity for such a flood to gather as swept down the steep slopes on the upper part of the Mill Creek drainage basin at Erie.

The Florida rainfall is of especial interest, however, in connection with the much-discussed project for the drainage of the Everglades. In the various engineering reports that have been made upon this project, two points have been emphasized. One is that in any system of drainage canals from Lake Okeechobee, or from the Everglades itself, suitable provision should be made for control gates, so that the level of the lake and of the ground water in the swamps may be prevented from falling too low in times of long continued drought. A special reason for this precaution is that at such times danger exists of fire getting into the dried-out upper portion of the swamp and causing widespread damage.

The second point made in the engineering reports upon the project has been the necessity for providing drainage canals of sufficient capacity to take care, to a reasonable extent at least, of the large runoff due to the heavy rainfalls which often occur in this section and which flood the canals.

Both these recommendations by engineers receive additional force in the light of recent events in the Everglades. According to the best information, Lake Okeechobee was last spring at the lowest stage ever recorded. The canals from the lake to the ocean which have been already completed contain no provision for checking the flow of water, and during a long period of dry weather the lake waters were drained away until a large area of the lake bed was bare. The Seminole Indians, who are accustomed to navigate the lake with light canoes, had great difficulty in getting across it.

Following this stage of unusually low water have come the recent storms. It is stated that at the time of the recent 15-in. rainfall in St. Petersburg, a heavy rainfall was general throughout Florida and particularly severe in the southern portion of the state. As a result Lake Okeechobee is reported at its highest stage. The drainage canals thus far completed are inadequate to carry off the water. Lands which were expected at this time to be drained and available for agriculture or town building are reported to be under 5 to 6 ft. depth of water. It is a common experience of engineers to find their recommendation of provision for extreme rainfall and runoff in hydraulic works falling on deaf ears. The widespread floods of the present season are a valuable object lesson to the public that engineers' recommendations as to provision for floods are based on practical realities and not on pure theory.

Letters to the Editor

Initial Tension in Rivets

Sir—In the fourth paragraph of a letter from Edward Godfrey, of Pittsburgh, printed on p. 184 of your issue of July 22, the following statement is made in regard to rivets in tension: "Pulling on the head of a rivet does not increase the stress on the rivet, but relieves the pressure on the plates," etc.

This statement seems to me to be in error, as follows: The theory of the initial tension is that the rivet in cooling contracts so that the distance between its heads would be less than the combined thickness of the plates joined, if an equal (or greater) resistance to compression were not offered by the plates. The initial stress is therefore due to the reluctance of the plates to reduce their combined thickness, the air and paint between them contributing slightly to the thickness. Any strain which tends to increase this combined thickness—such as tensile pulls—will obviously increase the stress.

In the symposium, of which Mr. Godfrey's letter is a part, I have not noticed any reference to the fact that the actual initial tension in a hot-driven rivet is very materially reduced by the simultaneous shrinkage of the plates. The heat from the rivet is very largely absorbed by that part of the plates adjacent to the holes, and any riveter can tell you that the plates get hot—hot enough to expand—nearly as hot as the rivet itself at the finish of driving. In cooling, both rivet and plates contract, the rivet only slightly more than the plates. Many a rivet is passed for "tight," on a hammer test, whose shank fills the hole and whose heads only barely touch—quite a proper condition, it seems to me.

Like Mr. Godfrey, I believe that rivets in tension, if used in properly designed details and only used where essential, are not entirely to be forbidden, as the initial tension (except in long rivets) will not be extremely high in rivets driven in the field.

IRA W. DYE.

872 N. Farson St., Philadelphia, Penn., July 24, 1915.

Water-Ballast Tanks and the "Eastland" Disaster

Sir—I have noticed with interest your comment on the water-ballast tanks of the "Eastland." It is true that when they contain water they tend to lower the center of gravity of the whole vessel; but unless the tanks are filled, the presence of water in them would in many cases decrease the positive metacentric height, righting moment and stability, the exact condition depending on the relationship between the vessel's beam and water line of flotation and the ballast water surfaces.

The metacentric height is represented by

$$GM = \frac{I - GB \times V - \Sigma i}{V}$$

In which I is the moment of inertia of the water plane of flotation, GB the distance between centers of buoyancy and gravity, V the volume in cubic feet of displacement and Σi is the summation of moments of inertia of water surfaces inside, such as water-ballast tanks, boilers, bilges, etc. It will thus be seen that in some cases the partial filling of water-ballast tanks may be "the last straw that breaks the camel's back."

The statement in your issue of Aug. 5, that the "Eastland" was in the habit of listing to one side or the other, is interesting to say the least. This condition is frequently observed in cargo-carrying freighters when light and with practically no coal on board. One often sees in New York harbor, a freight steamer high out of the water with a list to one side or the other. The reason for this is that the ship has been designed with an initial negative metacentric height; that is, in a light position she is unstable by a small margin. When she starts to roll to one side or the other, which she must necessarily do, she finally comes to a position of stability because the listing increases the breadth of the plane of the water line or line of flotation, which greatly increases the "I" in the formula to the point where GM, the metacentric height, is greater than zero, and the list goes no farther.

When the freighter is loaded with cargo, the center of gravity being lowered, the negative metacentric height becomes positive, so that when ready for sea the vessel is stable. A ship so designed must of course be loaded with ballast to make her safe when no cargo is available.

It is advisable for many reasons that the metacentric height of a ship should not be excessive, although to the layman it might appear that the greater the metacentric height, with the consequent righting moment, the safer a ship.

There are, however, disadvantages in a ship with too great a righting moment—that is, too high a metacenter—because she will be too stiff, and will roll in a sea-way with a sudden jerky movement that is very likely to snap her masts off, besides being extremely uncomfortable for passengers and crew. An easy, gentle roll is preferable for comfort, and also better for the ship, both as regards the effect on her structure and the possibility of shifting her cargo.

An experienced naval architect, or an engineer familiar with problems of vessel stability, would have known, in the case of this particular ship, from the statement made as to her inclination to list to either side, that when unloaded her metacentric height was slightly negative instead of positive. I will not comment upon the effect of the juggling done in trying to bring her to an even keel by filling water-ballast tanks on one side and emptying them on the other; but I am quite sure that anyone who has ever tried to right a listed vessel under these conditions by juggling with the water-ballast tanks will realize how futile the effort was.

Your closing paragraph I think is misleading, because it is just as well that the general public should not know too much about the metacentric height of a vessel. "A little knowledge is a dangerous thing" and might give rise to false ideas of security, such, for instance, as those apparently held by many of the passengers during the "Titanic" disaster, and later the "Lusitania," that these great ships were unsinkable.

A 56-in. metacentric height would undoubtedly give more righting moment to the same vessel than a 14-in. metacentric height; but if the 14-in. is sufficient, this will make a much more comfortable vessel, and the passengers will not be nearly so likely to suffer the disagreeable sensations of seasickness. Furthermore, a 56-in. metacentric height, if brought about by the addition of water-ballast, may be gradually reduced, or become nonexistent, if the water-ballast tanks are only partially full. The steamship line advertising the great stability of its vessel may have neglected to consider the negative effect on the stability of the free water careening in the partly filled tanks.

I disagree entirely with your concluding statement that "there can be no doubt that stability calculations and the margin of stability of vessels will hereafter have an importance in the minds of vessel owners and builders which they have never before possessed." The design, computation and construction of vessels in the hands of those capable of being entrusted with such work have always received all the care and consideration which you rather intimate will only now be given them as a new problem. As a matter of fact it is a very old problem.

F. R. HARRIS,
United States Navy Yard.

Philadelphia, Aug. 9, 1915.

Opposition to Concrete Chutes

Sir—Under the heading of "Concrete Chuting Predominant" there appeared an editorial in *Engineering News* of Aug. 12 to which I feel it necessary to reply. The protest against a free use of chuting concrete has been reduced in volume perhaps, so far as printed objections represent volume, but from conversation with engineers I am convinced that the voices in opposition have not been reduced in number.

For a number of years I have insisted that while "wet" concrete is preferable to the old-fashioned "dry" concrete, there must be care used in the amount of water. I have held that concrete which pours readily from a wheelbarrow is not the ideal concrete. It is too easy to add just the amount of water that will hurt the material. In the olden days when dry concrete was the rule we never heard of the dusting of floors. Today with finer grinding of cement and the use of considerable water it is difficult to obtain a nondusting floor. Perhaps if fine grinding of cement had not come in about the time the excessive use of water became common there might have been less heard of unsound concrete and the dusting of concrete surfaces. The ideal amount of moisture produces a mass that is sticky and pasty rather than free flowing. Such material requires to be assisted from a wheelbarrow by shovel or hoe. It is not necessary to state that a mixture of this kind cannot be chuted.

Those who wonder at the increasing use of chutes and the great popularity of this system of delivering concrete seemingly do not take into consideration the wonderful power of advertising. The makers of chuting devices advertise them extensively. They are able to produce records of very low costs in the delivery of concrete from mixer to forms and the contractor who does not use a chute when he is permitted to do so is a foolish contractor. I would do it myself if I were a contractor and the engineer permitted the use of chutes. As an engineer I forbid the use of chutes on work of any importance where the introduction of reinforcement allows a great reduction in section and the compressive strength of the concrete is relied on to the limit. Much of the unsoundness, so-called, of concrete reported is certainly due to the use of an excessive amount of water. The only thing to be done so long as chutes are being exploited is to await results and no results worth having can be secured for two or three years to come, when some of the chuted concrete will have attained an age of five or more years.

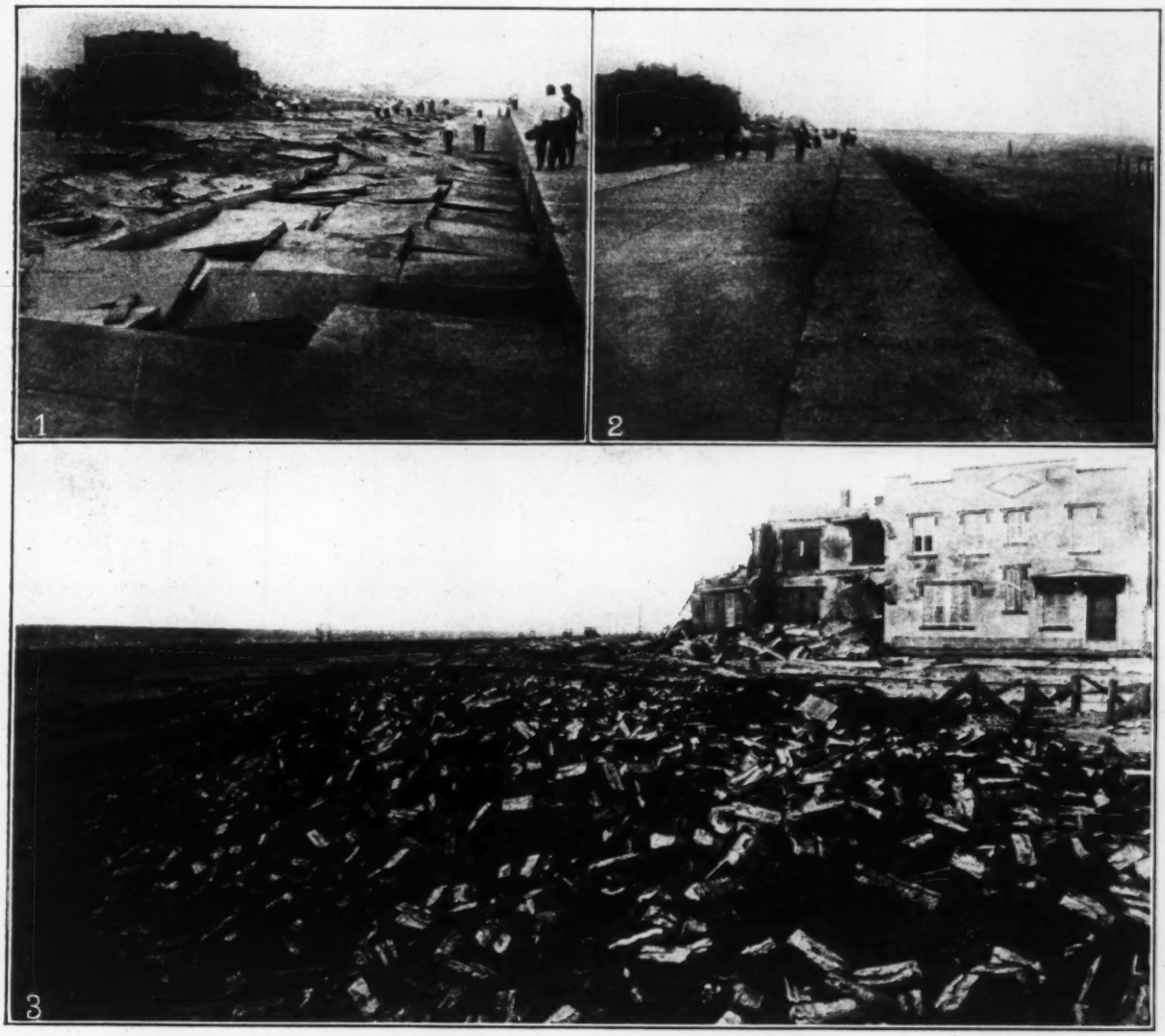
ERNEST MCCULLOUGH.

Monadnock Block, Chicago, Aug. 16, 1915.

Paper Bags vs. Cloth Bags for shipping hydrated lime was discussed by F. E. Kessinger before the National Lime Manufacturers' Association. Mr. Kessinger is attorney for the rope-paper-bag manufacturers. Comparing the cost of the two types of bag, he stated that paper bags holding 40 lb. each can be purchased for $17 per thousand. At this rate, when used for shipping cement, the cost for the bags would be about 17c. per bbl. The cloth bags holding 100 lb. and costing about 15c. each can be used for about four trips on the average before being worn out or lost. This makes the cost of the cloth bag per barrel of cement shipped about 15c. The difference of 2c. against the paper bag, however, is claimed to be more than made up by eliminating the trouble with customers in connection with the return of bags. Mr. Kessinger stated that the railroad freight Committee on Uniform Transportation of the railroad freight authorities is for the present permitting the use of paper bags in less than carload shipments as well as in full carloads. It is hoped that this condition can be made permanent, introducing a specification for the quality of paper bags that will be acceptable.

Galveston Storm Damage

The City of Galveston is quickly recovering from the recent storm; an 8-in. main across the bay is temporarily supplying water, cleaning up of the débris along the seawall boulevard and the silt and dirt in the north side streets is practically completed and a pile trestle is in process of construction as a substitute for the destroyed causeway approaches. Advices from the city state the most hopeful spirit prevails and suggestions that Galveston's prestige as a seaport has suffered a permanent setback are indignantly resented.



FIGS. 1 TO 3. ALONG THE GALVESTON SEAWALL AFTER HURRICANE OF AUG. 16, 1915

Fig. 1—Damage to pavement and boulevard caused by overfall of water at 19th St. Fig. 2—Looking east from 25th St. Fig. 3—Damage to pavement and backfill at 23rd St.

Seawall a Good Protection

As was pointed out in last week's issue of *Engineering News* the seawall successfully protected the south front of the city against the inundation which caused most of the 1900 damage. The additional views given herewith (Figs. 1 to 3) are from photographs of the Gulf front after the storm. Fig. 2, a view at 25th St., shows the Boulevard in surprisingly good condition. Here the waters of the Gulf were baffled and the overfall was unable to obtain a hold under the backfill, which extended a sufficient distance back from the seawall to prevent damage to the pavement. At 19th St. (Fig. 1), on the contrary, the concrete sidewalk was seriously damaged, though the seawall is intact. Fig. 3 shows the damage to pavement and backfill at 23d St. At this point the seawall was temporarily undermined and the backfill was washed out with consequent serious damage to the brick pavement.

The views in Figs. 4 to 7 show remarkably well the complete destruction of the earth-fill approaches of the causeway. The bay between Galveston Island and Virginia Point on the mainland is over 10,000 ft. wide and averages about 5 ft. in depth. The causeway, which was completed in 1912, consisted of a middle section 2555 ft. long made up of 28 reinforced-concrete arches with a 100

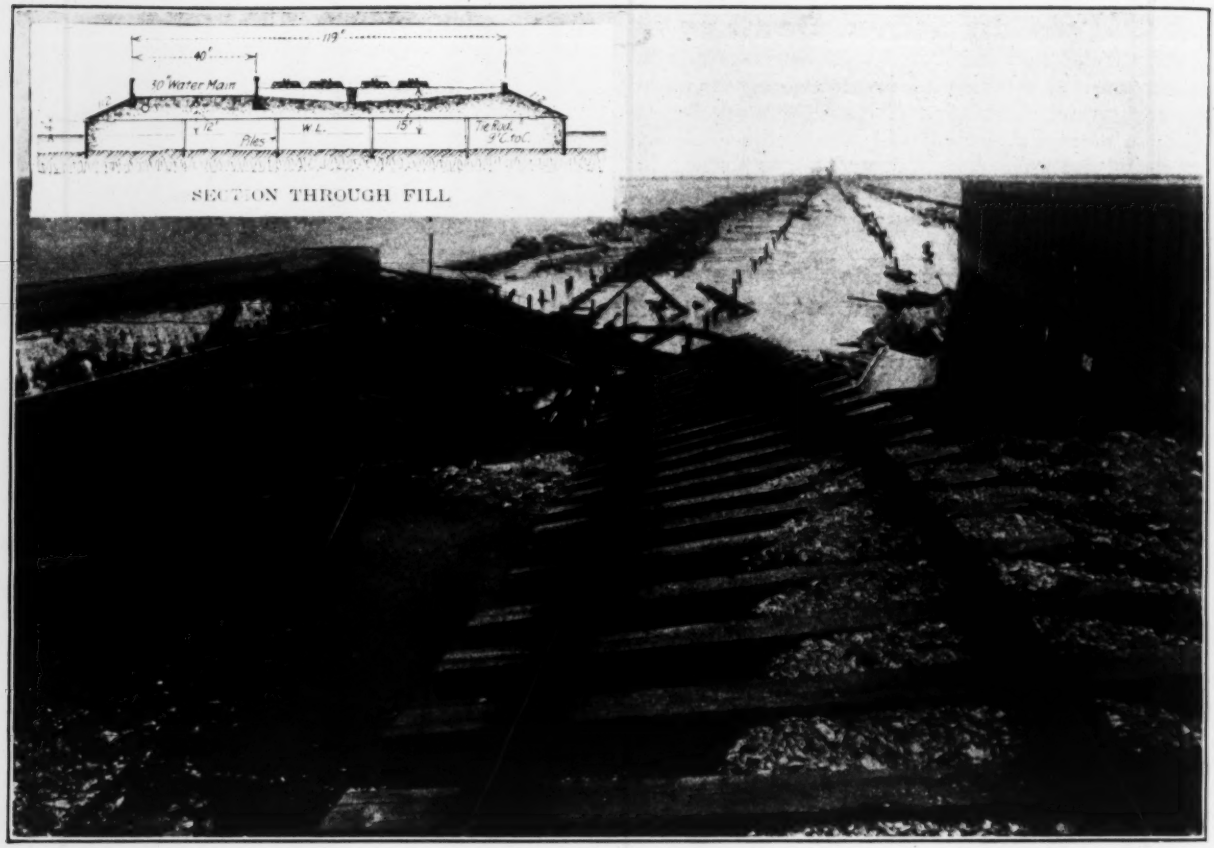


FIG. 4. LOOKING FROM EAST END OF CONCRETE VIADUCT TOWARD GALVESTON. RAILROAD SECTION

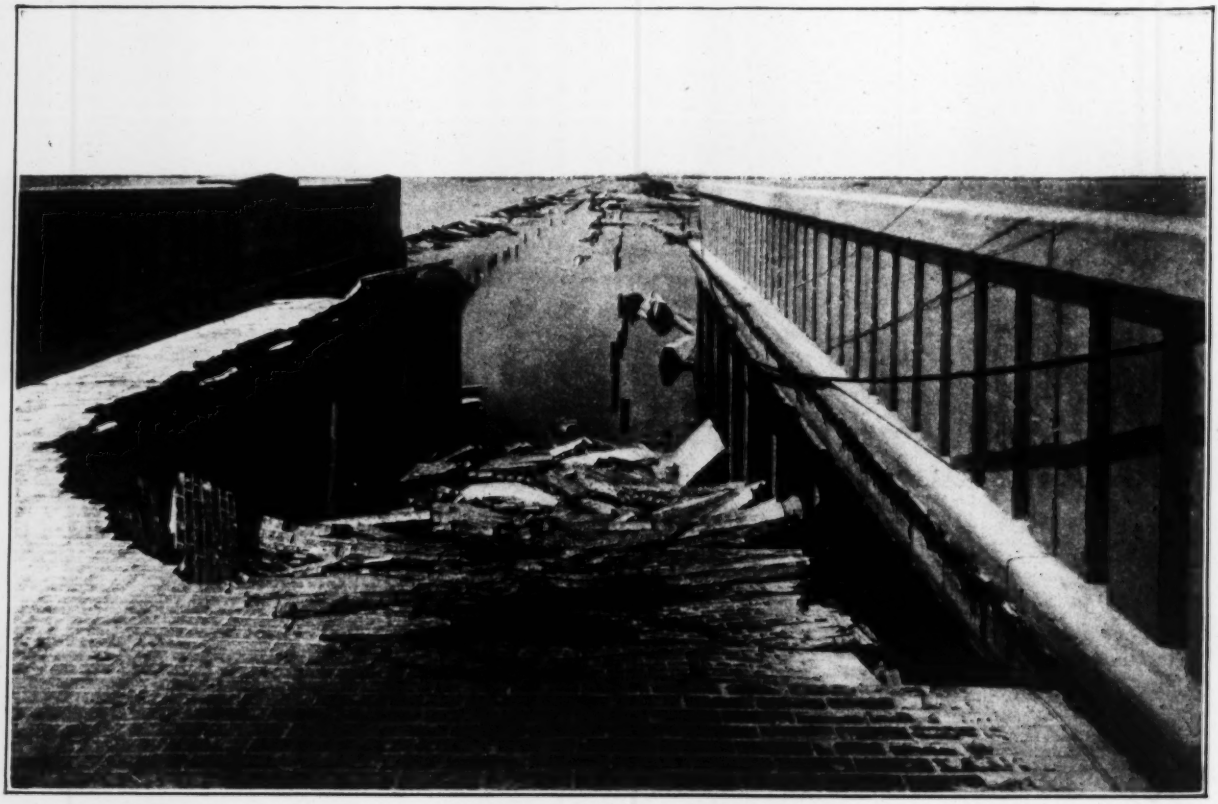


FIG. 5. LOOKING FROM WEST END OF CONCRETE VIADUCT TOWARD MAINLAND. BRICK-PAVED ROADWAY WHERE PROTECTED FILL BEGAN

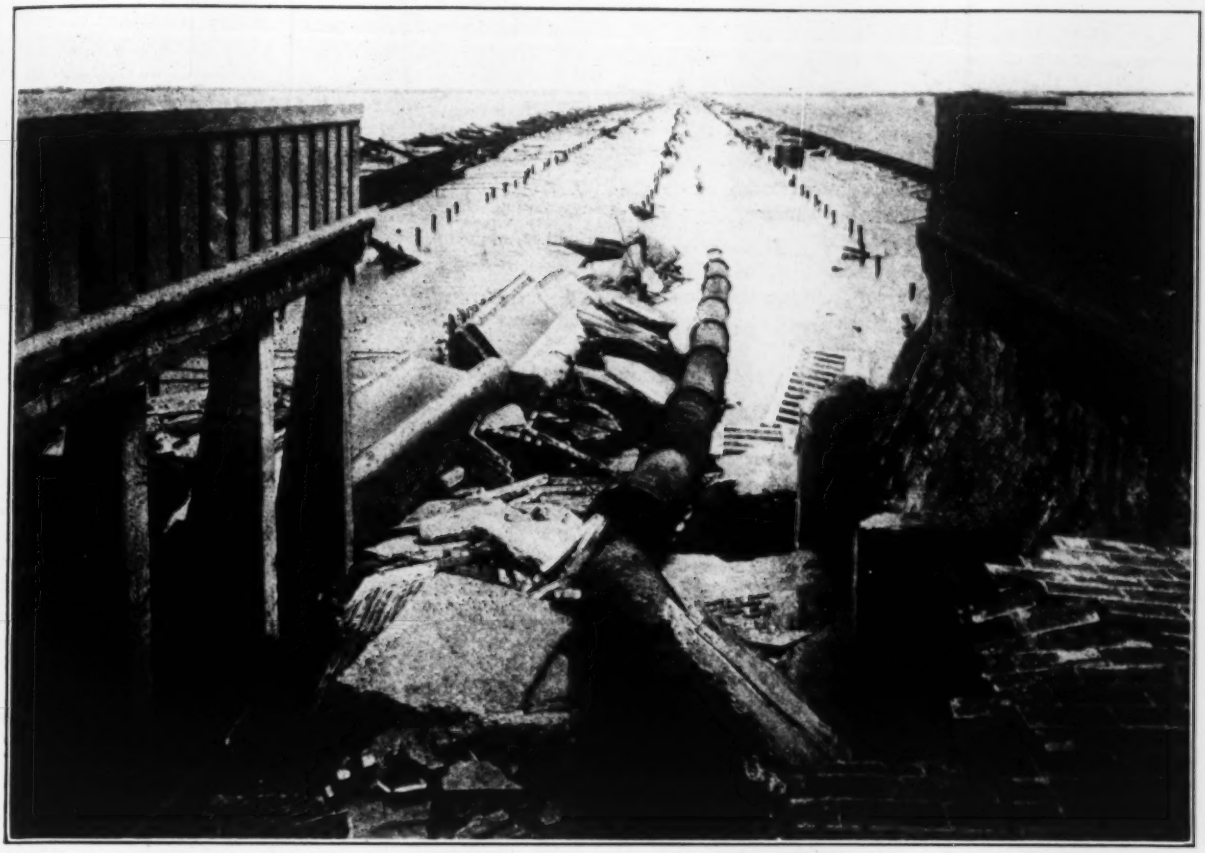


FIG. 6. LOOKING FROM EAST END OF CONCRETE VIADUCT TOWARD GALVESTON. ROADWAY SECTION

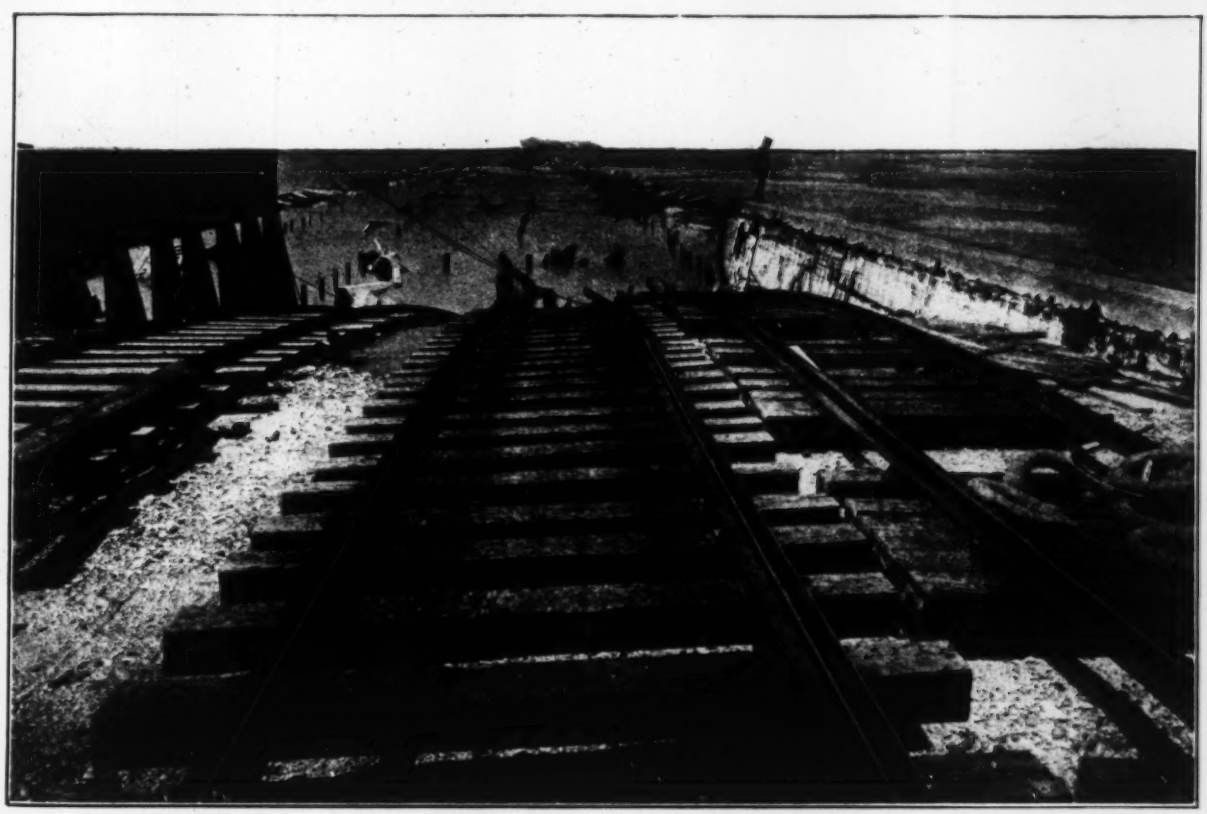


FIG. 7. LOOKING FROM WEST END OF CONCRETE VIADUCT TOWARD MAINLAND. RAILROAD SECTION. VIRGINIA POINT IN DISTANCE

ft. bascule, and two approaches of similar design, 3697 ft. long on the Galveston side and 4523 ft. long toward the mainland. The arch section and the bascule remain today practically as they were before the storm, except for the damage near the ends. The approaches, on the other hand, are destroyed as approaches although, as the views show, a large part of their structure remains.

The sketch in Fig. 4 gives a section through the approaches to the causeway. Briefly, the structure is an earth fill retained between a continuous row of tight reinforced-concrete sheetpiles and protected on its slopes with a continuous pavement of 6-in. concrete slabs. The sheetpiles were tied together every 9 ft. by tie-rods which rested on light wooden piles. The roadway was divided into two parts by a balustrade, one one side being a paved highway and on the other a sand-filled and ballasted railway carrying four tracks. Under the roadway ran the 30-in. water main. The views, taken from both ends of the concrete section, show the earth fill to be washed away, there remaining only the torn-out slabs and the light piles supporting the now useless tie-rods. As was to be expected the back-wash tore out a part of the fill and roadways over the last arches of the concrete part of the causeway.

Causeway Approach Design Faulty

An interesting comment on the design of the earth fills across Galveston Bay has been received from Wilmer Waldo, an engineer, of Houston, Tex. Mr. Waldo says in part:

"Economy may have dictated to the engineers engaged in the design of the Galveston Causeway, but even if it did much light-hearted confidence in the elements ruled somewhere in the councils of those in authority. The bare fact is that the design of the greater part of the causeway did not justify the evident confidence reposed in it.

"The central portion, that is, the arches and lift span, withstood the power of the storm as was to be expected, both being practically standard construction, but the balance of the structure at each end, about two-thirds of the whole, collapsed like an empty barrel with the hoops removed.

"The weakness in the protected roadway was not a theoretical one. It was visible to any layman who took the trouble to examine the construction. It required no technical demonstration to prove such weakness, especially to anyone who went through or who had observed the effects of the storm of September, 1900. Today the bulkheads of concrete piles forming the container for the filled roadway are standing and the water inside the bulkhead is somewhat higher than the bay level outside, showing that this part of the construction was tight and is tight yet. The fill above the level of the bulkhead, protected on its slopes with reinforced-concrete slabs had no more chance to stand than any other sand or earthen dump built in an exposed position.

"I was on the causeway at 5 p.m. Monday, Aug. 16, in order to make some observations in connection with the suspected weakness of the filled portion. Even at that hour the weather was very thick and it was growing dark, but the water could be seen piling up against the east side of the causeway and the wind and water were lashing the ballast from under the tracks. It seems that the pressure against the fill was enough to push it out bodily when once it was weakened under the protecting slabs. At any rate the storm continued long enough to eat the fill away gradually and drop the slabs into the bulkhead.

"Properly filled with rock, this work would have cost a few hundred thousand dollars more and would now require the mere relaying and ballasting of tracks in order to operate trains. It has been rather costly experience where none was necessary."

Conditions After the Storm

Further word from R. P. Babbitt, who went to Galveston immediately after the storm at the request of this journal, gives some details of the conditions in the city:

"The seawall prevented a repetition of the 1900 disaster for it broke the force of the waves and the demolition of buildings was confined to a comparatively small area along the Gulf front. The waters of the Gulf driven by the wind swept around the city and backed up in the bay to the northeast, gradually submerging the city streets to an approximate depth of 6 ft., choking the sewers with sand and silt, and putting the gas mains and electric-light system out of commission. The 30-in. water main which supplied the city with fresh water from the mainland was broken when the approaches to the causeway were washed away. A second water main which paralleled the causeway on the bottom of the bay was also broken, cutting off completely Galveston's water-supply. The people of the city suffered considerably from a lack of drinking water. Some of the more destitute dipped water from the gutters and other stagnant pools and attempted to subsist on this. For several days the luxury of a bath was denied and in fact it was difficult to obtain fresh water in which to wash one's face and hands. The food supply of the city ran low, and the people were placed on short rations, consisting principally of canned stuff.

"Practically every retail establishment in the business district of the city was flooded by the ocean that backed in from the bay. Thanks to the seawall, the waves did not roar through the streets of the city as they did in 1900. When the pressure of the Gulf waters crowding into the bay was relieved, owing to the cessation of the wind, the waters in the city streets subsided, leaving a coating of sand and silt behind in the stores, on the walls of the buildings inside and out and on the streets and sidewalks.

"The telephone system, which had been put out of commission by the storm, was partially resumed by installing an automobile engine in the telephone-exchange building and connecting up 1200 phones throughout the city. The Galveston *Tribune* resumed operations, driving its presses by motor-truck power, connecting its press with the rear wheel of a truck and getting out its issues regularly."

The New York Fire Department in 1914—Fire Commissioner Robert Adamson, of New York City, in a report to the Mayor states that there was an increase of 52½% in the number of fire-prevention orders complied with and 29½% in the number issued. A lawsuit was won which established the fire commissioner's right to recover the cost of extinguishing a fire due to "culpable and willful negligence." The total number of fire alarms received was 16,245, of which 1820 were false alarms. The total fire loss was $8,217,811, an average of $464 for a fire. In 1913 the loss was $7,467,911 in a total number of 12,598 fires. The population increased in this city in 1914 by 216,000. The Fire Marshal's Bureau reported 173 incendiary fires for the year. This was only a small part of the actual number of fires of this character. There were 50 arrests for arson and 37 convictions. The gradual passing of the fire horse is emphasized by a reduction of 174 last year; 1167 remain. Contracts were let for 76 pieces of motor apparatus to take the place of the horses retired.

Quebec Bridge Work in 1915

At the beginning of the 1915 working season the condition of the St. Lawrence Bridge Co.'s work on the Quebec Bridge was as follows: On the north side the anchor arm was only partly erected, nearly two panels not yet having been set; on the south side the approach spans were up, but nothing had been done on the anchor arm, not even the falsework being started.

FIG. 1. PRESENT STAGE OF ERECTION OF QUEBEC BRIDGE
North cantilever arm three panels out; south anchor arm about half erected, two months ahead of last year's work on north anchor arm

By the latter part of August the north anchor arm had been completed and three panels of the cantilever arm erected, as Fig. 1 shows. On the south side the anchor arm falsework had been put up, the floor placed, the lower chords completed, and three panels of bottom posts and lower diagonals placed.

Progress on the north side is slightly ahead of schedule. Comparing this year's work on the south side with last year's work on the north, the 1915 work is eight weeks ahead.

The north cantilever should be completed this season, whereupon the traveler will be taken down, transferred three miles downstream to Sillery, and recrected (in part) for the construction of the suspended span. The foundations for the falsework on which the latter is to be erected are now going in. By the time the south cantilever is finished, in 1916, the suspended span ought to be fully erected and ready to be moved and hoisted into place in the bridge. Thus the bridge may be in service at the close of 1916—a season ahead of what was thought probable.

In speed of erection the contractors have made a notable record. A specially high performance was the erection on the south shore of 1,240,000 lb. (bottom chords and laterals) in one week in July, and a total of 10,040,000 lb. for the month, in addition to transferring the interior falsework and setting the main-post shoes.

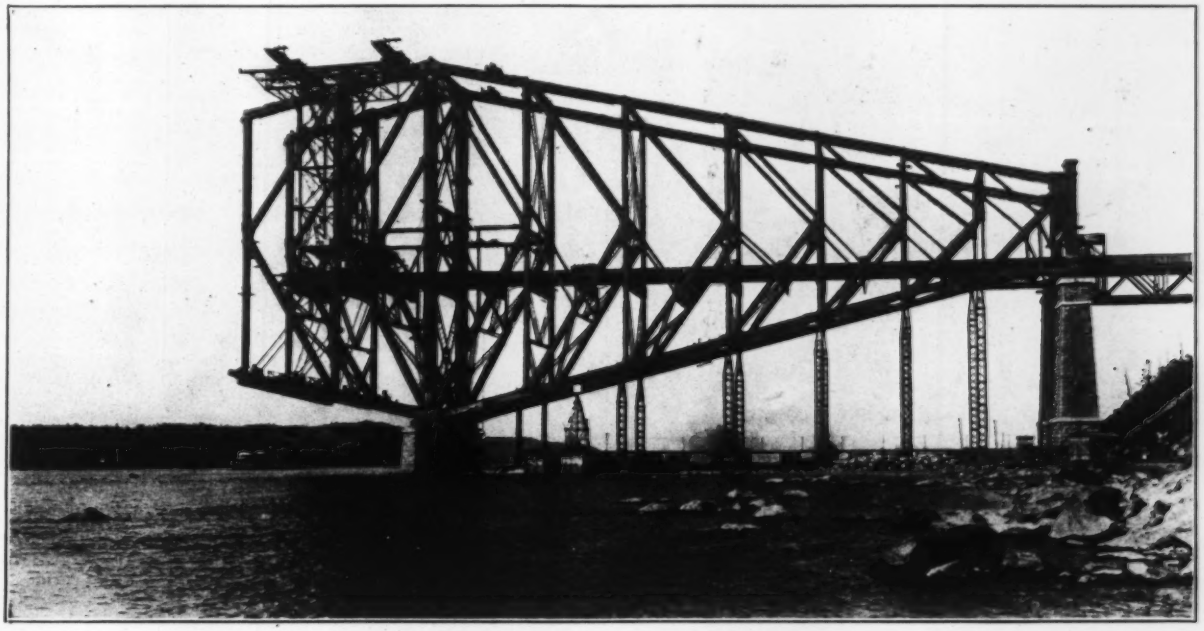


FIG. 2. NORTH CANTILEVER ARM OF QUEBEC BRIDGE ON AUG. 3, 1915

Precision of Setting Members

This speed is attributed by the contractors partly to the general design and largely to the excellence of the shopwork. Every connection is fully assembled in the shop. The bottom chord members (each panel of the

bottom chord is in four parts, being split longitudinally and divided once transversely between panel points) are machine-faced when fully assembled, and special attention has been paid to securing uniform temperature for all four webs. By the scheme of field erection for the chord, perfect bearing has been secured in every joint—not even a "feeler" being admitted.

The north shore main posts were set to a measured length only 0.002 ft. greater than the 292 ft. height between pin centers top and bottom, although of course such accuracy was accidental. This post was in 24 pieces and weighed 3,000,000 lb.

Particular effort has been made to have in the shop only work demanding accuracy. Rougher work, such as some of the falsework fabrication, was sublet.

Joining Large Compression Members

The bottom-chord erection scheme of G. F. Porter, Construction Engineer of the St. Lawrence Bridge Co., has worked perfectly. This is illustrated by the views

FIG. 3. ERECTING THE FOUR-PIECE MEMBERS OF THE BOTTOM CHORD ON FLYING BRIDGE

Figs. 3 and 5, taken on the north cantilever arm. A flying bridge projecting forward from the finished work is set just under the location of the chord to be set; it is hung by suspension rods from pins in temporary brackets attached to the web members. The quarter sections of the bottom-chord member are lowered into place on jacks, and the top flanges of the abutting sections are connected by temporary brackets, pins and links. Then lowering with the jacks throws the whole joint into full bearing, so that the bolting and riveting can be done.

Sunshine on the outer webs has frequently made a difference of a few thousandths of an inch in the bearing of these chord joints, but the riveting has been started if the difference did not exceed 0.012 in. In all cases the discrepancy disappeared as the riveting proceeded.

On the anchor-arm, instead of using the flying bridge, floor-beams are set longitudinally on the outer falsework to support the sections of the bottom chord. The whole anchor-arm chord is erected straight, from anchorage to main post, and after riveting all splices the falsework column jacks are lowered to give the proper camber

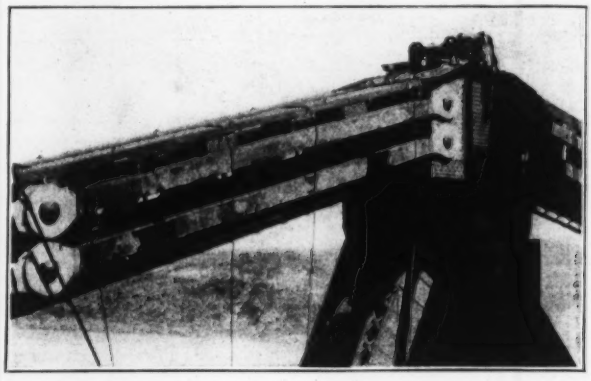


FIG. 4. THE DOUBLE EYE-BAR CHORD AT MAIN POST TOP

(about 6 in.). The cantilever arm is erected with the proper slight camber in each panel, and this flattens out under the increased load as the erection proceeds.

With three cantilever panels nearly completed, the effect of lifting on the anchor arm just begins to be appreciated. A rise of about $\frac{1}{16}$ in. is apparent at the first four panel points. This is not a lifting off the falsework, but merely a decrease of the compressive shortening of the falsework columns.

Moving the Traveler

Moving the traveler forward is accomplished as follows: The traveler cranes are run back, which eases up on the front truck springs. The erection brackets (bolted to the ends of the track girders to distribute

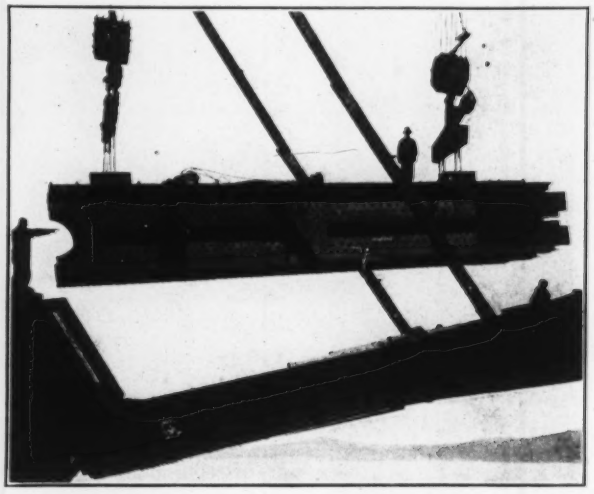


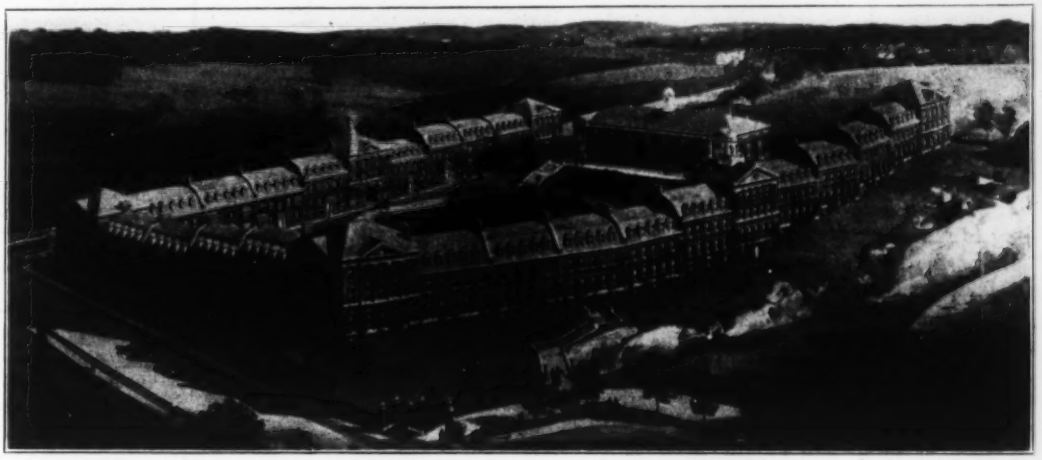
FIG. 5. SWINGING ONE OF THE BOTTOM CHORD PIECES INTO PLACE

the traveler load on two floor-beams—these being designed for only half the traveler load) are then taken off, which allows the setting of the new forward stringers track. The traveler is moved forward on the new length of track, the cranes being moved forward as the traveler

advances so as to distribute the load over the front and rear trucks. When the front of the traveler comes above the next pair of floor-beams ahead, pedestals are mounted on these floor-beams, and the traveler shimmed up on the pedestals by manipulating the cranes, thus cutting the truck springs out of action and getting a rigid bearing.

New Buildings in Rensselaer Polytechnic Institute

Construction of a dining-hall and six initial units of a dormitory quadrangle for the Rensselaer Polytechnic Institute at Troy, N. Y., is now under way. As shown in the accompanying view, there will be 27 separate dormitory units, built about three sides of a court, east of the gymnasium and athletic field and adjacent to 15th St. and Ave. B of the City of Troy. Across the end of the court will be a dining-hall accommodating about 400 men. All the buildings will be of Harvard brick, with limestone trimmings, and of fireproof construction, the floors and partitions being of brick and concrete.



PROPOSED DORMITORIES AND DINING HALL; RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

Each separate unit of the dormitory system will house twelve students, four on each floor. Two students will use one study and each man will have a separate bedroom. There will be a bathroom on each floor.

Six of the units will be larger than the other 21, the larger ones costing $16,000 apiece and the others $12,500.

A. T. White, of Brooklyn, N. Y., has given the sum of $50,000 for four units of the dormitory, and Capt. Robt. W. Hunt, of Chicago, $16,000 for one of the larger units, which will contain the main entrance to the group. Mrs. Russell Sage has given $100,000 for the dining-hall.

Air Analyzer for Determining Fineness of Cement

Experiments during the past three years at the United States Bureau of Standards have resulted in the development of an air-analyzer which is claimed to give results superior in accuracy to the sieve methods prescribed for the determination of cement fineness. For some time it has been felt that the variation in sieve results obtained under the standard methods is entirely too great for practical purposes. The mechanical construction of the sieves does not seem to be constant, and the method of operation can be varied to give different results.

The device is described in detail in "Technologic Paper No. 48," which may be obtained from the Bureau of Standards, Washington, D. C. It is described as follows:

> This apparatus consists of a vertical brass pipe about 3 in. in diameter and 5 ft. long, at the lower end of which is attached a glass bulb in which the cement to be tested is placed. Air at constant pressure is blown into the cement through a glass tube or nozzle in the side of the bulb, and as the air can escape only through the vertical stack, it carries with it the cement dust, which is caught in a flannel hood surmounting the stack. The air flow in the stack is very uniform, and in a short time all the dust will be removed from the cement, leaving a granular residue in the glass bulb. This residue is weighed, and the amount of dust is determined by subtracting the weight of the residue from that of the original sample of cement.
>
> Different grades are obtained by using different-sized nozzles, and thus a number of separations can be made in the very fine portion of the cement. With the aid of the microscope the size of the largest particles in any given separation can be readily determined, and in this manner the apparatus is standardized without reference to the size of the nozzles and other parts of the apparatus or the air pressure used.
>
> It has been found that the cement "flour," that is, the portion of cement which contains no perceptible grit when rubbed between the fingers, consists of particles less than 0.0007 in. in diameter.
>
> The apparatus may be used for separating and grading any hard-grained materials, such as ground quartz, emery and other abrasives. The air-analyzer in modified form is also capable of separating many other powders; for example, paint pigments, plasters, clays and similar materials.

The Cement Trade of Australia has not interested the United States greatly, on account of the high freight rates compared with those from England and Scandinavia. The Interstate Commerce Commission has been investigating this industry in Australia, and finds that in 1913, the last year for which full statistics are available, 200,000 tons of cement were produced in Australia, and 124,100 tons were imported. The average wholesale price per cask of 400 lb. was $3.04 with duty paid, the duty during that period being 18c. per 112 lb. for cement from England, and 24c. per 112 lb. from other countries. The imports were distributed as follows: England, 31,000 tons; New Zealand, 2700; Germany, Austria and Belgium, 81,000; Scandinavia, 9000; United States, 400. The local production was divided among five factories—two in New South Wales, with a capacity of about 145,000 tons; two in Victoria, with a capacity of about 38,000 tons; one in South Australia, about 17,000 tons. According to Commercial Attaché William C. Downs, Melbourne, the effect of the war on the cement situation was to raise the price to $5.48 per cask; it then dropped to $4.38, varying thereafter from this figure to $4.87. Contracts for cement at the last figure have been placed in Scandinavia and Japan. Freight rates from Norway and Sweden are reported to be from $8.52 to $9.73 per ton.

News of the Engineering World

Phenomenal Rise in the Meramec During Recent Flood

The rain of Aug. 19-21 in the St. Louis district caused disastrous floods in the Meramec River to the south and west of the city, the greatest damage probably occurring at Valley Park, about twenty miles to the southwest. The total drainage area of the Meramec is 3619 sq.mi.; at Valley Park it is probably 3530 sq.mi. The valley extends about one hundred miles in a straight line above Valley Park and the length of the river through that stretch measured along the thread of the stream is probably over two hundred miles. The drainage basin is rugged and hilly and comparatively thinly populated.[1]

The town of Valley Park is built on a level about 30 ft. above ordinary low-water in the river and has never before been seriously damaged. There are a number of industries located at this point, the principal one of which is the Valley Park Glass Co., and above the town on both sides of the stream summer camps and club houses are located.

According to the best reports the river rose about 7 ft. on the night of the 19th and about 17 ft. additional on the 20th. It was practically stationary during Saturday the 21st and it was generally assumed that the high water had been reached, but during the night of the 21st and the day of the 22nd an additional rise of 19 ft. occurred, making a total of 43 ft. above low water. This submerged practically the whole town well above the ordinary second-story level, and a large part of the rise having come during the night, it appears that a majority of the people were marooned in their own houses. As far as can be ascertained, however, no lives were lost, but the damage to the property has been enormous.

This stage of the Meramec was probably partly a result of the condition of the Mississippi River, into which the former discharges twenty miles below Valley Park. The Mississippi rose from a gage of 22 on Thursday to a gage of 30 on Sunday, which is danger line.

Bids for Albany Sewage Pumps and Grit Chamber

Bids for a 75,000,000-gal. automatically operated electric sewage-pumping station and for a large grit chamber will be received by the City of Albany, N. Y., on Sept. 7. The pumps will work under a maximum head of 39 ft.

The pumping equipment will consist of six vertical centrifugal pumps each direct-connected to a vertical motor. Three of the pumping units will be operated by 2200-volt constant-speed alternating-current motors, each unit having a capacity of 10,000,000 gal. in 24 hr. The other three units will be operated by 575-volt variable-speed direct-current motors, each of these units being designed to pump from a minimum of 5,000,000 to a maximum of 15,000,000 gal. in 24 hr.

In a number of ways the pumping station is somewhat unusual in design. The pumps are located in a circular dry well, an annular well outside of the dry well being utilized to serve as the suction well. Unusual care has been taken in designing the station to provide easy access to all parts of the mechanical and electrical equipment and especial arrangements have been made to prevent deposits in the suction well.

The grit chamber is believed to be the largest one of its type yet designed in this country. Special means are provided for maintaining a practically uniform velocity through the grit chamber with a wide range of sewage flow.

The pumping station and grit chamber, as well as the sewage-disposal works which are now under construction, were designed by Hering & Gregory, Consulting Engineers, New York. Wallace Greenalch is Commissioner of Public Works, Frank Lanagan is City Engineer and Stephen B. Vernon is engineer of intercepting-sewer design and construction.

Am. Soc. C. E. Admission Rules

The Board of Direction of the American Society of Civil Engineers has recently adopted by letter ballot the following rules to be applied in interpreting the society's constitutional requirements for the admission of new members:

The requirements fixed by the constitution are intended to mark the minimum which should be recognized for admission to membership, and the maintenance of a high standard necessitates that these provisions should be interpreted conservatively to the end that the fitness of applicants shall be established beyond doubt.

In order to shape more definitely the requirements in the classification of applicants for admission or for transfer, and to assure as far as possible that applicants for membership meet the spirit of the requirements established by the constitution, it is the sense of this board:

1. That no applicant should be admitted to any grade whose qualifications do not clearly exceed the minimum requirements of the constitution.

2. That each applicant for admission or for transfer shall furnish whenever possible, the names of persons, whether members of the society or not, who have personal knowledge of his work in each of the positions enumerated in his application and when possible shall have more than five references, and his application shall state in detail the character and extent of the works upon which he has been engaged, and the degree to which he was responsible for their design and execution.

3. That an applicant for membership or for transfer who, at the time of making his application is engaged on work for which an engineering education or training is not clearly essential, shall not be elected or transferred unless he shall have markedly superior qualifications as to professional experience.

4. That the professional work required for admission to the grade of member shall be of a markedly higher order, and the degree of responsibility materially greater than for the grade of associate member.

5. That unless a candidate is eminently qualified for the highest grade, admission to that grade should be by transfer from the grade of associate member.

[1] See discharge measurements in water-supply papers of the United States Geological Survey. Vol. 7, No. 10. Progress report of stream measurements for the calendar year 1904, Part 8.

Dexter Brackett*

Dexter Brackett, Chief Engineer of the Metropolitan Water-Works of Massachusetts, died at his home in Brighton, Mass., on Aug. 26. He had been in poor health since last February, but the severe illness which resulted in his death was short. He was born in Newton, Mass., in 1851 and in 1868 was graduated from the Brighton high school near Boston. The next year he entered the city engineer's office, Boston, where he remained for 26 years. In 1874 he was assigned to the supervision of the distributing system of the water-works. In this position he was largely instrumental in developing an unusually adequate piping system for the city and in creating a plant exceptionally efficient in other respects.

DEXTER BRACKETT

In 1895 he resigned his place with the City of Boston to accept the position of engineer of the distribution department of the Metropolitan Water-Works. In this capacity he had charge of the construction of the pipe system, pumping stations and distributing reservoirs within the limits of the Metropolitan District.

From 1907 to the time of his death, Mr. Brackett was Chief Engineer of the Metropolitan Water-Works. He had always been greatly interested in questions relating to the consumption and waste of water and had written several papers and reports upon the subject. He persistently advocated the use of meters within the Metropolitan District as a means for reducing the waste of water, and had the privilege of seeing his views adopted and the consumption of water thereby reduced. Up to 1907 the consumption had been increasing so rapidly as to point out the necessity for an additional supply within a few years, but the gradual introduction of meters reduced the consumption of water so rapidly that no additional supply will be needed for many years, the consumption now being less than two-thirds of what it would have been had the rate of increase continued. Mr. Brackett was a member and for three years a director of the American Society of Civil Engineers. He had been president of the Boston Society of Civil Engineers and of the New England Water-Works Association, and was a member of the American Water-Works Association. In addition to his papers on consumption and waste of water, he contributed papers on many other subjects relating to water-works engineering. He was married in 1875 and leaves a widow and a son, Herbert D. Brackett.

*Contributed by Frederick P. Stearns, Consulting Engineer, Boston, Mass.

Novel Protest Against a Dam

Three engineers testified against the safety of dams, at a hearing on a water-supply dam being built for Coatesville, Penn., held at Harrisburg on Aug. 24, 1915, before the Pennsylvania Water-Supply Commission. The hearing was on application of mill owners in Coatesville, who want the permit for the dam to be revoked. The three engineers testified in their behalf.

Health Commissioner Samuel G. Dixon took the lead in conducting the hearing, as he has been the chief figure in ten years' work to secure a new water-supply in place of the polluted and dangerous raw river supply which Coatesville borough now enjoys. He referred repeatedly to the 1912 typhoid epidemic in the borough, when over 300 deaths occurred, and demanded that the protest should take the form of a definite project for securing another supply without delay. The protestants made a general proposal for a dam in another valley.

The protested dam is already under contract. It is to be a hollow concrete structure 35 ft. high, on granite foundation, and crosses Rock Run 2 mi. above the borough. Half a dozen mills are in the valley below; the owners claimed that failure of the dam would sweep away their mills. The protest was made in the name of Worth Bros., the Lukens Iron & Steel Co., the Coatesville Boiler Works, Craig, Ridgeway & Sons Co., and some 1300 individual signers of a petition. The population of the borough is 12,000. The mill owners urged that this population depends on the mills, and that the mills would be driven away if the dam were built. They proposed that another stream, Buck Run, be dammed, which could affect only a village of 100 houses. The mill owners have previously made many efforts to kill off the Rock Run project, including several court actions, which failed.

The engineers' testimony, abstracted from notes made by a representative of *Engineering News* at the hearing, was as follows:

E. P. Dawson, Assistant Chief Engineer, Philadelphia & Reading Ry.—Failure of the Rock Run dam would flood the valley for a long distance, damage much property, and possibly cause loss of life. He has not studied the plans or considered the strength of the dam. His protest, for the railway company, is based wholly on the location of the dam.

Maj. Cassius M. Gillette—The failure would cause more appalling destruction than the Austin (Penn.) dam failure. The Rock Run site is good and the specified foundation is good, and a good dam can be erected. A dam built strictly to the design and specifications would be "a good dam as dams go." An earthquake even would probably not destroy it, but dynamite could do so. There is small risk in a well-built dam. The chief danger is from violence. German emissaries could destroy all plants in the valley by dynamiting the dam. Strikers could do the same. However, if abandoning the Rock Run site means indefinite delay in providing a new water-supply, he favors the dam. Typhoid is more of a menace than the dam.

Herbert W. Hatton, Wilmington, Del.—Many dams fail; 18 dams failed in 1912, many of them in Pennsylvania, the smallest being 15 ft. high. He has no criticisms of the design, but thinks it would be safe. However, dams fail from causes not anticipated. Even rock foundation is not a guarantee of safety; the Stony River Dam, of the same type as that proposed, was on rock.[1]

Dr. Dixon shut off further testimony on the risk remaining in dams built with best engineering skill, by the statement that bridges could not be built or railways run on the principle that perfect safety must be provided, free from every possibility of accident.

The Water-Supply Commission has not yet announced its decision on the protest.

⁂

A Tunnel Cave-In occurred in the 15-ft. sewer under construction between Macon and Halsey St., Brooklyn, N. Y., Aug. 26. The collapse is reported to have been caused by the failure of the shoring. One man was killed and two injured.

A Bridge Collapsed under a passenger train on the Atchison, Topeka & Santa Fé Ry., Aug. 27. The bridge was over Date Creek, 70 miles north of Phœnix, Ariz., and had been weakened by a recent flood. The engine passed over the bridge safely, but the smoking car fell through, causing the death of four persons and injuries to twelve others.

The Explosion of a Tank Car of Gasoline in the Westchester freight yards of the New York, New Haven & Hartford R.R. on Aug. 23 destroyed five other carloads of freight. More than a dozen cars were set on fire by the burning oil. The damage was estimated at between $50,000 and $55,000. The cause of the explosion is unknown.

The St. Paul Union Station is temporarily held up following a second rejection by the Chief of Engineers, Gen. Don. C. Kingman, of the submitted plans for the changes in the Mississippi River channel and harbor lines at and about the new station. These plans were submitted by the railroad companies building the station. General Kingman's memorandum accompanying the returned plans makes it clear that the revisions must be made more with a view to improving the navigability of the river than to accomodating the needs of the station. Any new scheme submitted will evidently have to come through the city authorities and will have to guarantee a better accommodation for freight transshipment. The proposed station was described in "Engineering News," Mar. 11, 1915.

United States Leads in Exports—According to the Department of Commerce the United States for the first time in its history leads the world as an exporter. Our total exports in the fiscal year 1915 aggregated $2,768,600,000, as against $2,170,100,000 for the United Kingdom, the figures representing in the case of the United States an increase of 17 per cent. and in the case of the United Kingdom a decrease of 30 per cent. when compared with last year. American exports in the fiscal year 1915 included domestic products to the value of $2,716,200,000, against $2,329,700,000 in 1914; and foreign products, $52,400,000, against $34,900,000 in the preceding year. British exports in the same periods included British and Irish produce, $1,744,100,000 in 1915, against $2,557,200,000 in 1914; and foreign and colonial produce, $426,000,000 in 1915, compared with $526,500,000 in 1914.

An Excursion of Engineers through western Canada, in connection with the International Engineering Congress, has been arranged by committees representing the members of the principal British, Canadian and American civil engineering societies who reside in British Columbia and Alberta. A special excursion train is to leave San Francisco Sept. 25 for Seattle. The passengers will travel from Seattle to Victoria by boat, and after a day spent in sightseeing at Victoria will leave for Vancouver on the morning of the 28th. Here two days will be spent in visiting water-power plants of the British Columbia Electric Ry. Co. and other engineering works. The special train will start from Vancouver eastward over the Canadian Pacific on Thursday, Sept. 30. Stops are scheduled at Ruskin, to see the plants of the Western Canada Power Co., and at Glacier, where the seven-mile tunnel now being driven through the mountain by the Canadian Pacific Ry. will be visited. Sunday will be spent at Lake Louise. Further stops at Seebe, Calgary, Bassano and Brooks are scheduled.

[1]This dam, which failed Jan. 5, 1914 (see "Engineering News," Jan. 22, 1914), was distinctly not founded on rock. It had a cutoff wall reaching shale over a part of its length, but the section that failed was founded on clay.—Editor.

PERSONALS

Mr. Vannoy H. Manning, M. Am. Inst. M. E., Assistant Director of the United States Bureau of Mines, has been appointed Director to succeed the late Dr. J. A. Holmes.

Mr. Robert A. Zentmyer, a civil engineer of Tyrone, Penn., has been appointed a member of the Pennsylvania State Water-Supply Commission at a salary of $3000 per annum.

Mr. Samuel Rea, M. Am. Soc. C. E., President of the Pennsylvania R.R., is seriously ill at the Polyclinic Hospital, Philadelphia, where he was taken about two weeks ago for a minor operation.

Mr. William C. Pickersgill, for the past nine years Assistant Engineer of the Board of Water-Supply of the City of New York, has been appointed Designing Engineer of the Providence, R. I., Water-Supply Board.

Mr. C. D. McArthur has again assumed the office of Chief Engineer of the Blaw Steel Construction Co., after more than a year's absence. He is in personal charge of the engineering-service department of the company.

Mr. E. A. Moritz, Assoc M. Am. Soc. C. E., Engineer of the United States Reclamation Service, Washington, D. C., has been appointed Office Engineer of the newly established executive office of the Reclamation Service at Denver, Colo.

Mr. Harvey C. Miller, M. Am. Soc. C. E., Consulting and Contracting Engineer, formerly at 1 Madison Ave., New York City, is now agent for the American system of reinforcement (unit wire fabric, unit spirals and unit frames), with offices at 40 West 32nd St., New York City.

Mr. C. E. Hicks, who was graduated from Stevens Institute of Technology in 1876, has been appointed City Engineer of Mechanicsville, N. Y., under the new commission-plan city government. Mr. Hicks has had many years' experience in private practice at Mechanicsville.

Mr. B. F. Bush, President of the Missouri Pacific and Iron Mountain railways, has been appointed Receiver of these railways. Mr. Bush is a civil engineer by education and early experience. He entered the railway service in 1882 as a rodman on the Northern Pacific Ry., and subsequently was Locating Engineer and Division Engineer.

Mr. L. C. Fritch, M. Am. Soc. C. E., Assistant to the President of the Canadian Northern Ry., has been appointed General Manager of the lines east of Port Arthur, Ont. Mr. Fritch was formerly Chief Engineer of the Chicago Great Western R.R. He is a graduate of the University of Cincinnati and began his railway work in 1884 as a supervisor's assistant on the Ohio & Mississippi Ry.

Mr. A. J. Himes, M. Am. Soc. C. E., Valuation Engineer of the New York, Chicago & St. Louis R.R., Cleveland, Ohio, has been appointed Engineer of Grade-Crossing Elimination of the company, which department has just been restored. Mr. Himes was formerly in charge of grade-crossing elimination work in Cleveland, which was completed about two years ago. Since then he has been Valuation Engineer.

Mr. J. A. MacRae, formerly Mechanical Engineer of the Michigan Central R.R. at Detroit, Mich., has been appointed Mechanical Engineer of the Louisville & Nashville R.R., with headquarters at Louisville, Ky. He is a graduate of the mechanical engineering course of the University of Illinois and began his railway experience as a draftsman in the office of the Mechanical Engineer of the Chicago & Northwestern Ry.

Mr. John T. Beamer, of Chicago, Ill., and associates have purchased the American-Rio Grande Land & Irrigation Co., which developed the 100,000-acre irrigation project near Mercedes, Tex., claimed to be one of the largest private irrigation developments in this country. The company was organized about 10 years ago by Mr. B. F. Yoakum and others, of St. Louis, Mo. The purchase price is reported to have been $3,500,000.

Prof. Charles Lee Crandall, for many years head of the department of railway engineering and geodesy in the college of civil engineering of Cornell University, has retired from active service. Both the University faculty and the trustees have passed resolutions in appreciation of his services to the University, which began in 1872. Professor Crandall was graduated with the first class of the University in that year. He was City Engineer of Ithaca from 1870 to 1891.

Messrs. George F. Swain and John F. Stevens, M.'s Am. Soc. C. E., and W. C. Loree, former General Manager of the Baltimore & Ohio Southwestern R.R., have been appointed a commission to formulate plans for a more efficient system of port and terminal facilities for New York City. The com-

mission is appointed to serve for three years, but its estimated annual expenses of between $100,000 and $110,000 have not yet been appropriated by the City Board of Estimate and Apportionment.

Mr. E. N. Layfield, M. Am. Soc. C. E., Acting Secretary of the Western Society of Engineers has been appointed President of the new State Board of Examiners of Structural Engineers, in accordance with the recently enacted state license law for structural engineers. Other members of the Board are Messrs. John T. Hanley, Chicago, Secretary; Ira O. Baker, Professor of Civil Engineering at the University of Illinois; John W. Musham, Secretary of the Condron Co., Chicago, and C. C. Stowell, Civil Engineer, of Rockford, Ill.

Mr. Thomas C. Atwood, M. Am. Soc. C. E., former Supervising Engineer of the Yale Committee of Twenty-One, Inc., on the construction of the Yale Bowl, has opened an office in the Chamber of Commerce Building, New Haven, Conn., and in addition to his work on the Yale Bowl will engage in the general practice of civil engineering, specializing in college athletic fields and in water and sewerage works. He is a graduate of the Massachusetts Institute of Technology and has had several years' experience with the Metropolitan Water-Works of Boston, Mass., the water-works of Philadelphia, Penn., and the Catskill water-supply of New York City.

OBITUARY

Christopher Bell Bouton, President of the Union Foundry Works, Chicago, Ill., died Aug. 26, aged 76 years.

P. A. Gorman, former Street Commissioner of Waco, Tex., and a pioneer railway builder of the Southwest, died Aug. 15, at his home in Waco, aged 63 years.

William Graver, President of the William Graver Tank Works, of East Chicago, Ind., died at his residence in Chicago on Aug. 25. He was born at Chambersburg, Penn., in 1842, and went to Chicago in 1884.

Edward Bates Pleasants, Chief Engineer of the Atlantic Coast Line R.R., died Aug. 26, from apoplexy, while in his private car en route from his home in Wilmington, N. C., to Baltimore, Md. He was 65 years old and a native of Baltimore.

Max Hebgen, Vice-President and Chief Engineer of the Montana Power Co., died Aug. 24 at the Presbyterian Hospital, Chicago, Ill., aged 46 years. He was born in Milwaukee, Wis., and began his career in the shops of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Penn., about 1886. Soon after he went to Butte, Mont., where he was employed as a lineman by the old Butte Electric Light & Power Co. He remained continuously in the employ of this company through its various absorptions of other companies, and at the time of his death was Vice-President and Chief Engineer of the consolidated concerns, the Montana Power Co., which is one of the largest hydro-electric companies in the world in the extent of its developments. He was an intense worker; a man entirely self-educated. He entered his profession endowed with magnificent health, a sound intellect, a distinct inventive capacity and an unlimited capacity for hard and successful work. He was beloved by all who knew him, and it is probable that no more successful or popular officer of any corporation has existed than Mr. Hebgen, who, while occupying this position of great popularity in the organization, was also a thorough disciplinarian. His popularity was based on the profound respect which his organization held for his character, his abilities and his physical and moral courage. He is survived by a wife and one son.—H. M. Byllesby, Chicago, Ill.

ENGINEERING SOCIETIES

COMING MEETINGS

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

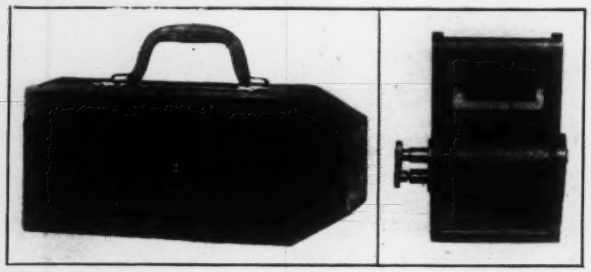
AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

New England Water-Works Association—The program for the annual convention at the Waldorf-Astoria Hotel, New York City, Sept. 7-9, includes an illustrated address by J. Waldo Smith, Chief Engineer of the Board of Water-Supply of New York, on the present status of the Catskill water-supply of the city; a paper on the sanitation of a large watershed; short papers on joints for water mains and the laying of various kinds of mains, detecting leaks, etc.; descriptions of the water-supplies of Norwalk, Conn., Salem and Beverly, Mass.; short papers and discussions on valve types and installations, testing fire-line meters and pump-slip tests; an illustrated lecture on the Kensico reservoir, New York; papers on the decolorization of water by storage, forestry work in watersheds, infiltration galleries of Long Island water-supplies, New York State control of public water-supplies, Fall River (Mass.) water-supply, grubbing a large reservoir and a progress report on service pipes. Excursions include a sightseeing trip on Fifth Ave. for the ladies, a boat trip in the harbor and an inspection of the Kensico Dam.

Appliances and Materials

Camera for Reading Meters

A camera for obtaining reliable meter readings, applicable to gas, electric and water installations, has just been placed on the market by the Eastman Kodak Co. The reading is made by placing the front of the camera against the meter dial and pressing downward on the exposure lever. This action automatically turns on light, operates the shutter and turns off the light. With this instrument mistakes of reading



THE "FACTOGRAPH" CAMERA FOR REGISTERING METER READINGS

are obviated, and in the case of a disputed reading the records are at hand. A reading of the peak on maximum-demand meters can be made before the meters are reset for the next month.

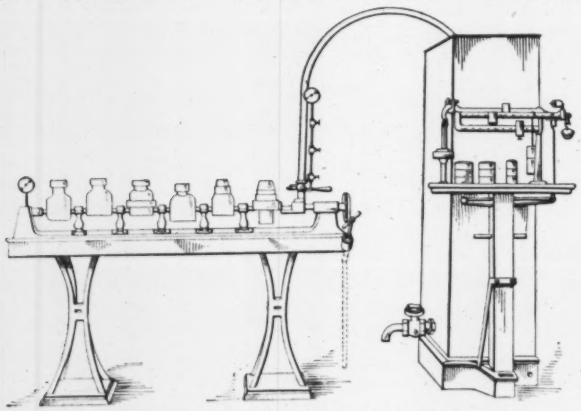
The camera measures 4¼x5¾x12¼ in., is incased in mahogany and equipped with a simple automatic shutter permitting exposures varying from ½ to ½ sec. Light is furnished by four 3.8-volt tungsten miniature lamps operated by two 4-cell dry batteries stored in the case. The film is 1½x2⅛ in. and of the cartridge type. Pressing a button converts the camera into a flash lamp for locating meters in dark cellars.

The "Factograph" can be leased on payment of $22.50 each. Films are supplied in spools of 75 readings per spool. These are packed in cartons of 50 spools, 10 cartons to the case. The price is $125 per case, $12.50 per carton. The dry batteries cost $36 per 100, the miniature lamps $8.50 per 100 and a desk reading stand can be purchased for $2.50.

* * *

Water-Meter Tester

The outfit shown in the accompanying sketch has been devised by the H. W. Clark Co., of Mattoon, Ill., for the convenient, quick and economical testing of ⅝- to 2-in. water meters. It comprises (1) a standard-type Fairbanks scale with a special beam, (2) a 100-gal. galvanized-iron tank with quick-opening outlet valve, (3) a test table on which six



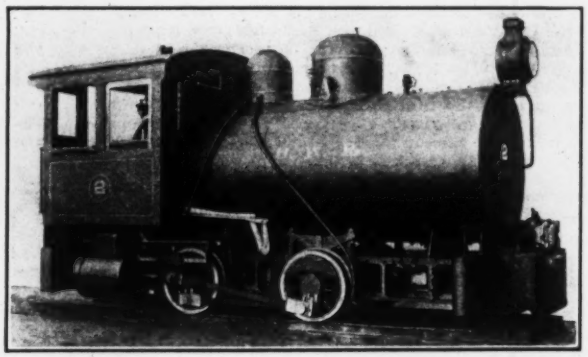
CLARK METER-TESTING OUTFIT

⅝-in. meters, or various combinations of other sizes, may be set up in series, and (4) special self-cleaning sensibility-test valves for 1/32, 1/16 or ⅛ normal flow. A slow-opening inlet valve is used to eliminate water hammer; gages at inlet and outlet show the loss of head through the meters. A unique feature is the percentage bar on the scale beam, showing meter error. The price ranges from $38 up.

Steam-Storage Industrial Locomotive

The fireless or steam-storage locomotive shown in the accompanying view has been put into service by the Ohio Wood Preserving Co. for switching on the standard-gage tracks at its plant. The storage tank has a capacity of 250 cu.ft. and is intended to carry a maximum pressure of 180 lb., so that no reducing valve is required between the tank and the cylinders, as in some European engines of this type which employ a higher pressure. The tank is kept about half full of water. It is recharged with steam four or five times a day from the boiler plant of the creosoting works, a boiler pressure of 150 lb. being desirable. A steam dinkey engine would have to refill its water tank about the same number of times.

The cylinders are 17x16 in., this large size being used to



STEAM-STORAGE LOCOMOTIVE FOR THE OHIO WOOD PRESERVING CO.

enable the engine to develop a fair proportion of its maximum power at low pressure. In fact, it can be run by itself on a pressure as low as 5 lb. With one charge it can run about five miles with two or three ordinary freight cars on level track. The cylinders are placed at the back end, to give a better balance. The slide valves are driven from a valve gear of the Stephenson type, and the exhaust may be discharged at rear, top or side as desired. The factor of adhesion is based on a tank pressure of 60 lb. The engine was built by the H. K Porter Co., of Pittsburgh, Penn.

* * *

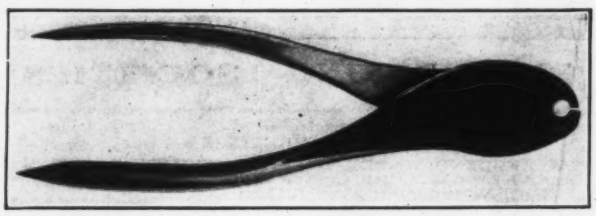
Spacers for Reinforcing Rods

A device known as the "Securo" locking spacer, for supporting concrete reinforcing rods in the forms, serves not only to support them at the proper height and give them the proper spacing, but also locks them in position so that they cannot be displaced before or during concreting. The device is a light bar passing beneath the rods and having depending lugs which rest on the bottom of the form and so keep the rods at the desired height. At the location of each rod the bar has two flexible clips which are bent around it, and these serve to insure the use of the proper number of rods. The device is made by the Metal Building Materials Co., of Chicago, Ill.

* * *

Handy Blasting-Cap Crimper

A new cap crimper, comprising the crimper proper and with the handle pointed at one end for making holes in dynamite cartridges, and shaped at the other end to serve as a screwdriver, is shown in the accompanying view. The crimper makes a cylindrical crimp of the blasting cap to the



NEW CAP CRIMPER

fuse, thus eliminating the possibility of cutting off the powder train in the fuse and consequent misfires. It also leaves a vent alongside the fuse for the escape of smoke from the burning powder inside the cap, thus allowing a stronger spit into the fulminate charge. It is manufactured by the E. I. du Pont de Nemours Powder Co.

Engineering News

VOLUME 74 SEPTEMBER 9, 1915 NUMBER 11

Fast Concreting on Brooklyn-Brighton Viaduct, Cleveland

Rapid progress marks the construction of a long concrete arch viaduct which Cuyahoga County is building in the southwestern part of Cleveland, Ohio. The viaduct is 1726 ft. long, and includes six 128-ft. arches besides many shorter ones. An existing steel viaduct carrying a heavy traffic complicates the work, as it interferes with the new structure and requires it to be built in longitudinal halves to maintain traffic. In less than 11 months' time, including the winter shutdown, the Bates & Rogers Construction Co., Chicago, has completed the west half.

Construction began in September, 1914, shortly after the contract was signed. By the end of the season one abutment and a few piers were partly built, while most of the foundation pits had not even been started. The view Fig. 1 shows how the viaduct appeared July 28, 1915, as seen from Brookside Park road, to the west. The structure looks practically complete, but the entire east half is yet to be built (see view Fig. 2). The contractors expect to finish by the end of the present season.

The design, shown by Fig. 3, is unusually successful as regards esthetic effect. This lies partly in the general proportioning, partly in the arch-rib curvature (adjusted to the dead-load pressure line, with short end curves joining the piers tangentially) and partly in the omission of heavy pilasters over the piers in favor of a column system throughout, with columns intentionally so spaced that they do not come over the piers.

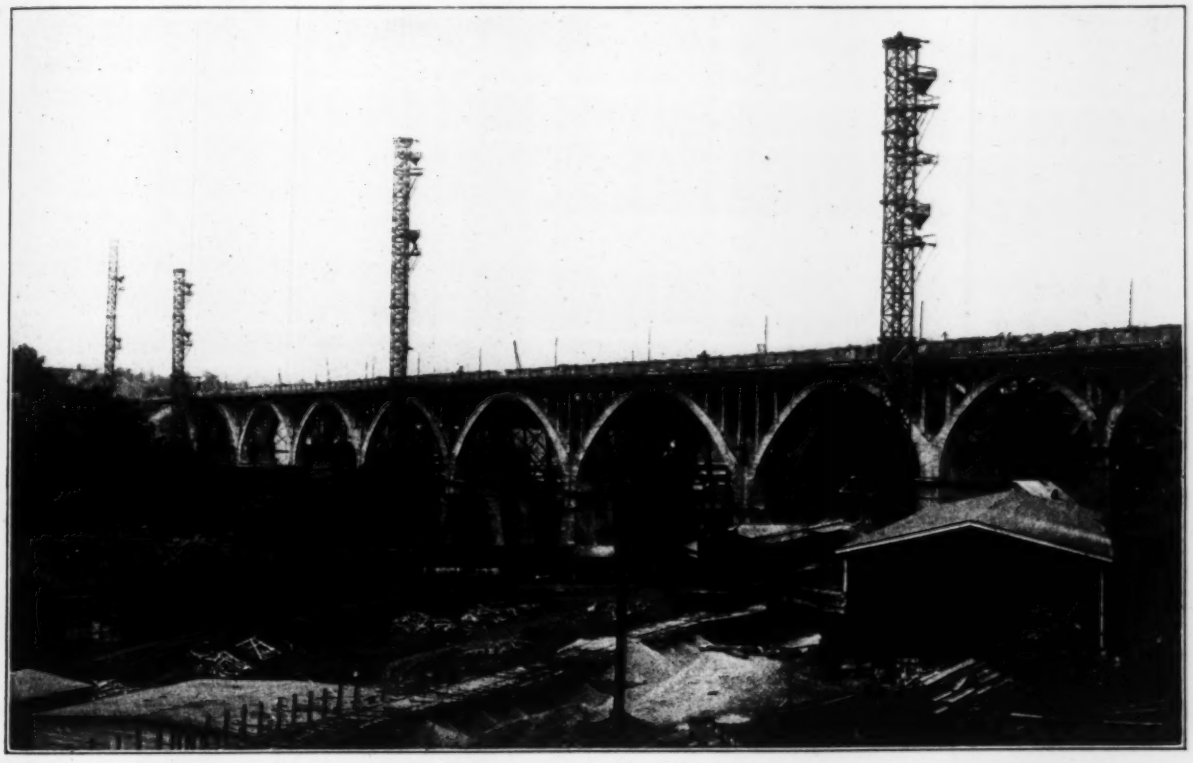


FIG. 1. BROOKLYN-BRIGHTON VIADUCT, CLEVELAND, AT COMPLETION OF WEST HALF

The six largest arches have a span of 128 ft. clear (139 ft. c. to c. piers) and a rise of 43 ft. clear. A prominent characteristic of the viaduct is the use of unsymmetrical arches—with one skewback at higher elevation than the other—at the side slopes of the valley. This permits of starting both arches on a pier from the same spring elevation and at the same time keeping the pier tops about the same distance above ground at all piers.

All the arches, in fact, are unsymmetrical, though most of them are only slightly so. Throughout the middle part of the viaduct the plane of the spring lines is parallel

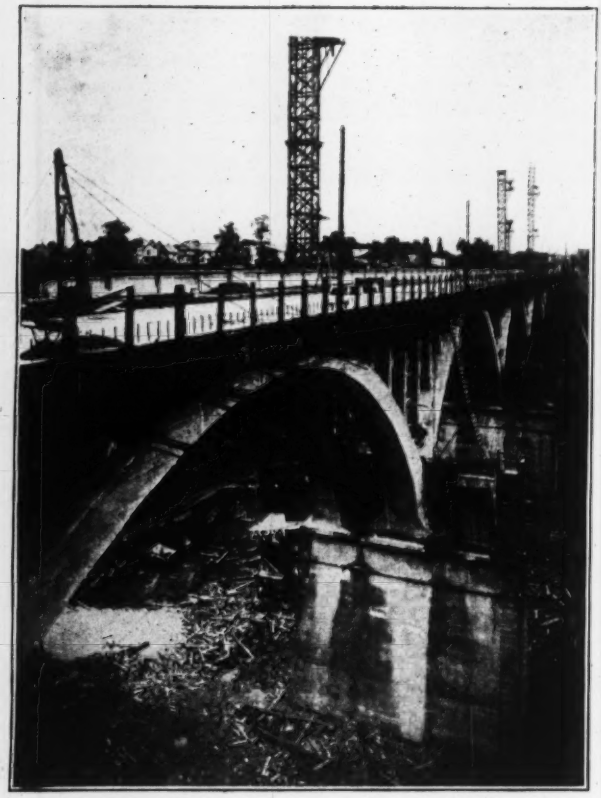


FIG. 2. EAST FACE (MIDDLE) OF BROOKLYN-BRIGHTON VIADUCT

View taken same day as Fig. 1

to the roadway slope (0.4% up toward the south). The arch curves themselves have vertical axes, except for the short terminal curves near the spring line, whose radii are adjusted to give the proper terminal elevation.[1]

The floor-panel length was made uniform (11 ft. 7 in.) with a view to duplication of floor forms as well as to securing good appearance. Span lengths were adjusted to be multiples of this length.

The extrados faces of the ribs in adjoining spans are connected by a curve. In the transverse plane the feet of the four ribs on each pier are joined by heavy filleting in the form of an elliptical invert arch that has value for both appearance and rigidity of the structure.

Expansion joints in the floor, located over every pier, are at mid-length of a stringer. The two half-stringers act as cantilevers and for this purpose are made deeper than the regular stringer (see cross-section in Fig. 4). The joint is perfectly open and has no load to transmit, to interfere with free expansion as in the case of a stringer-end sliding on a seat.

The floor, a normal arrangement of slab, stringers and floor-beams, is depressed 8 in. on the width of the double-track street-car line to make space for the track (4-in. steel I-shaped ties, 7-in. rails, 1-in. depth of ballast cushion under ties). The roadway is divided between tracks by a low concrete curb-wall, inclosing and fendering the 10-in. sockets of the trolley-poles.

The pavement is to be of 4-in. granite block on half the width, and "Durax" granite block on the other half, both laid on sand cushion on asphalted burlap waterproofing.

Interference with the Old Viaduct

West 25th St. is carried south across Big Creek valley by an old steel viaduct. The site of the new viaduct, on a slightly revised alignment, is west of the old structure, but overlaps it on most of the length, as the plan in Fig. 3 shows. However, it was possible to build the west half of the concrete viaduct complete without disturbing the old viaduct except to cut a narrow strip off its west side for a length of some 200 ft. at the north end. The

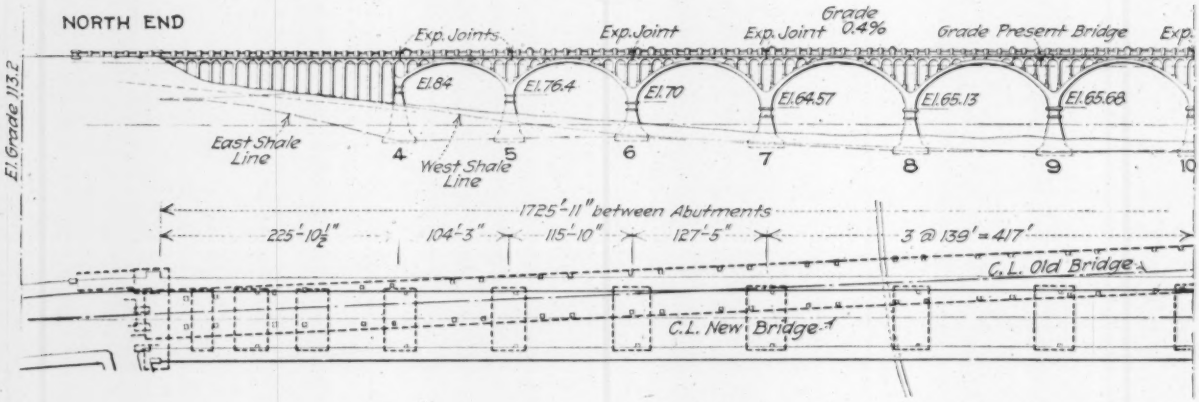


FIG. 3. BROOKLYN-BRIGHTON VIADUCT ACROSS

There are some other features of the design that merit study. The four ribs have no transverse connection, but are independent for the entire span length; only the floor and columns connect them. A low cross-wall 18 in. thick, between ribs just over the piers, provides some lateral stiffness. There is also a pair of diagonals between the inner posts nearest each pier.

[1]The terminal curves are shorter than they appear in the elevation of one arch in Fig. 4, as the drawing has the main curves somewhat off scale.

completed half could then carry the traffic, whereupon the old viaduct could be torn down and the east half of the new structure built. This procedure was followed.

The old viaduct floor-beams in the northerly interfering section were burned off by oxygen flame, and the cut ends of the remaining width supported on temporary timber bents. Cars operate over a single track in this narrowed portion, turning out to double track beyond.

The new structure was started at the south end and built northward in regular progression. Floor construction near

the south end, arch-rib concreting north of here, pier concreting beyond, and footing work and excavation at the north end went on simultaneously.

One of the conditions that facilitated this arrangement was the uniform and excellent character of the foundation soil. Hard shale in massive deposit lies near the surface, outcropping even high up on the bluffs. Therefore the construction of the footings was simple work, free from risk of delay or necessity for change of method. The excavation was done with the use of steam tripod drills except at the pier just south of the creek, where the cutting was so deep that 20-ft. holes were put down by hand drills, as the machine drills tended to stick. The muck was handled by a stiffleg derrick set up alongside the pit, into carts which hauled it away to approach fills.

The supply route of materials determined the type and placing of plant and thereby largely dictated the construction methods. Two railways pass through the valley, not far from the third-points of the length of the viaduct; the stone, sand, cement and other materials could thus be brought in direct and unloaded immediately alongside the viaduct at two different points. This meant storing and mixing in the valley and hoisting the mixed concrete.

The contractor chose tower hoisting and spouting in preference to handling by cableways. A layout showed that four towers could command the whole length—two located at the points of storage and mixing and two so located as to receive concrete from the spouts of the other two and rehoist it to be chuted again. Fig. 5 shows diagrammatically the location of the towers relative to the viaduct length; transversely they were set to clear the west face of the deck about 5 ft. The tower locations and heights were laid out for a chute angle of 2¾ to 1.

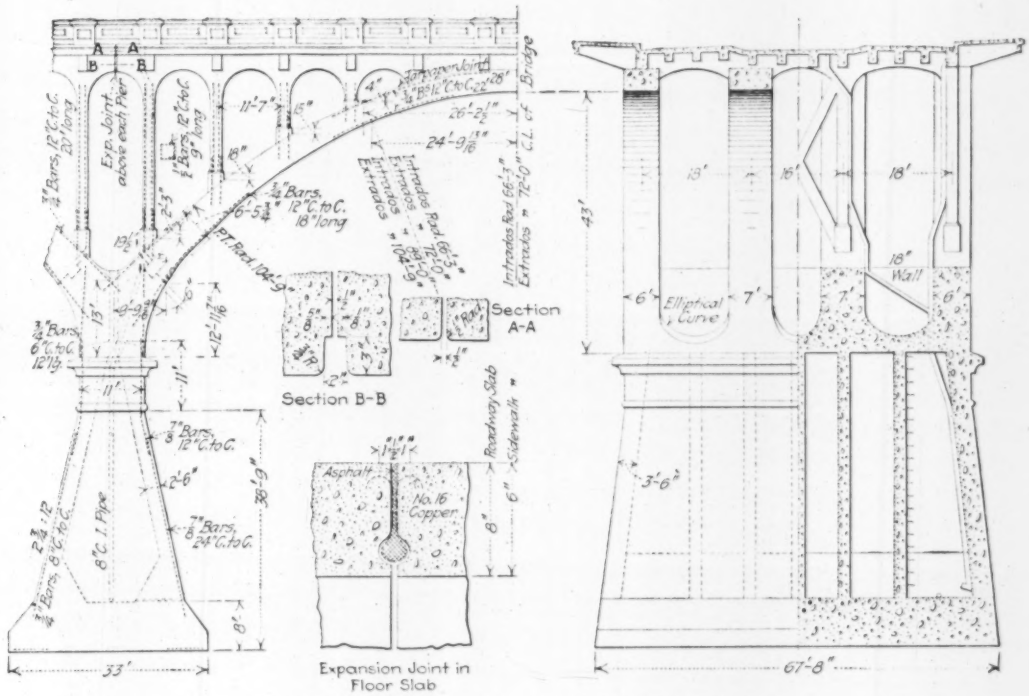
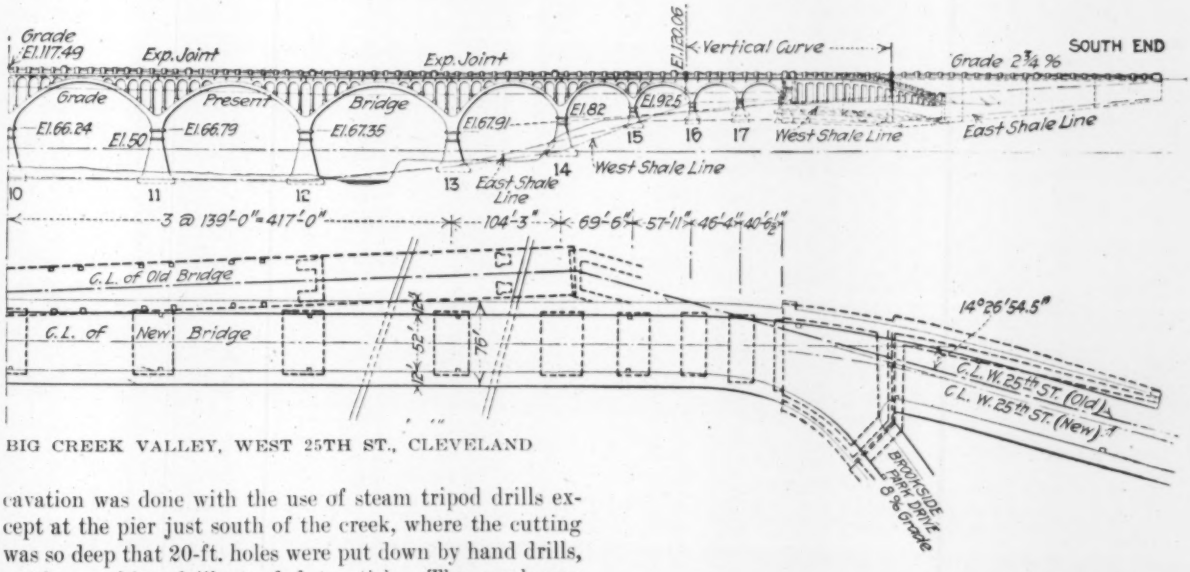


FIG. 4. TYPICAL DETAILS OF ARCH CONSTRUCTION



BIG CREEK VALLEY, WEST 25TH ST., CLEVELAND

As the piers were designed to take unbalanced dead-load thrust, the centering and concreting could go on in any desired order.

Steel centers of the three-hinged arch type were adopted, with a view to using the centers of the large 128-ft. spans also for the shorter spans by taking off sections. The tie-rods of the centers were used only in setting and in slacking; when in place the centering arch was supported vertically by blocking on the skewback belt-course and horizontally by wedges against the arch stubs that had been centered with the piers. The sketch Fig. 6 shows how the centers for a pair of ribs are braced together and

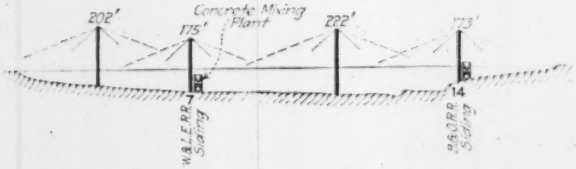


FIG. 5. LOCATION OF CHUTING TOWERS

how they are sectionalized for ease of erection and handling. The American Bridge Co. built the centers at its Ambridge plant.

Centers were provided enough for six spans (two ribs each, the ribs being concreted in pairs). For the three small spans at the south end, trussed wooden centers were built. These were intended to be used over once; the pair of centers in each span was left in place—these spans having been concreted last April—and will be rolled over next month to do service for the construction of the two easterly ribs of the same span.

Handling the Centers

The centers were erected by two 80-ft. gin-poles, each of which lifted a half-arch of one truss (see Fig. 6; the two sections of the half-arch were bolted together on the

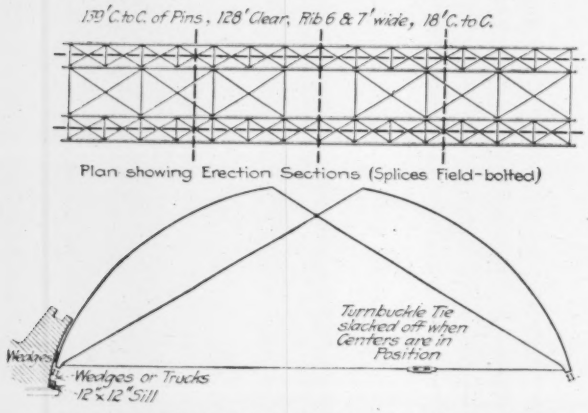

130' C. to C. of Pins, 128' Clear, Rib 6 & 7' wide, 18' C. to C.
Plan showing Erection Sections (Splices Field-bolted)
Turnbuckle Tie slacked off when Centers are in Position
Wedges or Trucks 12"x12" Sill

FIG. 6. SECTIONALIZING AND BRACING OF ARCH CENTERS

ground) and set it to join with the other at the crown pin. The tie-rod being put in and screwed up and the arch guyed, its mate was similarly hoisted and set and the pair braced by placing the lateral members. Then the parallel pair of centering arches was set and the bracing between the pair put in, completing the centers for a pair of ribs.

In taking down the centers, falls hung from the finished concrete arch were used to lower the half-trusses to the ground. Here they were unbolted, lifted on wagons and trucked to the next arch that was to be centered.

Arch and Pier Forms

The forms for piers and arches were made to be used only once; the contractor did not consider it economical to build sectional forms made to be used repeatedly.

The arch forms are shown typically by the sketch Fig. 8. Horizontal side sheathing was scribed to the bottom lag-

FIG. 7. VIEW UNDER MIDDLE OF WEST HALF, BROOKLYN-BRIGHTON VIADUCT

The appearance of the staining is due to heavy rain just before the picture was taken

ging and its upper line left irregular. Vertical wales with tie-rods through the arch held the sheathing. Top lagging was nailed to the under side of a 2x2-in. curve batten nailed on the inside of the sheathing; 1-in. bevel fillets were tacked in the four corners of the form.

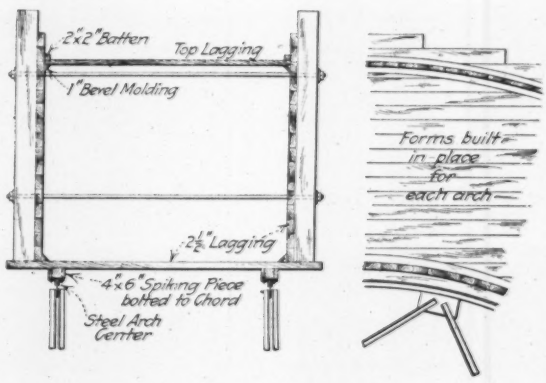


FIG. 8. ARCH-RIB FORMS

These forms proved rapid and simple in construction, and did not call for any hoisting appliances.

In designing both arch and floor forms, special care was taken to limit the deflection; ⅛ in. was considered the maximum permissible deflection. The two chief limits

in design were deflection in bending and cross-grain crushing under washers and wales.

Alternate Concreting of the Ribs

The steel centers were capable of carrying one panel excess load on either side. Therefore the concrete was placed in a sequence that kept the load balanced within one panel-load.

Fig. 10 sketches the procedure. Concrete from the chute was allowed to run down the outside of the top lagging on one side of the middle, to a hole cut a few feet above the spring. When the rib had filled up to the level of this hole the hole was closed and the spout was swung to discharge on the other side of the middle.

The concrete running down on that side went through a hole cut at an elevation several feet higher than the other. After this another lift on the first side was concreted, and so on alternately until the central section was reached. Top lagging was omitted for a length of 12 ft. at the middle, and the chute discharged direct into this open space, filling the middle 50-ft. length of ring.

The arch-rib top lagging was removed the day after concreting. The sides were taken down the second day. The centers were struck in 21 days; but in two spans the time was only 15 days, without injurious effect.

Column and Floor Forms

The column forms, like all the others, were unlined, that is, had plain wood faces. Special care was taken in building them to get a smooth face. Two coats of paraffin form oil were put on.

The floor forms and column forms were always built up together, but the columns were poured two days before the rest. The day after, the column forms were stripped—the floor-beam forms being supported independently on transverse 12x14-in. by 38-ft. outlooker timbers—and the columns rubbed.

The floor forms were built sectional and this in such a way as to make the path of transmission of load in the forms the same as in the finished structure. The stringer forms rested on ledges of the floor-beam forms, and the slab forms on the stringer forms. All parts were designed with 1-in. clearance horizontally, and the clearance space was covered with a 2-in. strip of tin nailed over (see view, Fig. 9).

Floor forms were built for 600 ft. length of floor, and floor concreting progressed without much interruption. Because of the sectional construction the panels of form removed from the rear were simply carried to the front of the work and built up.

FIG. 9. A SPAN OF FLOOR FORMS, BROOKLYN-BRIGHTON VIADUCT

The heavy items of reinforcing steel were handled on the forms by small gantries (large wooden horses) from which a chain block was hung. The floor-beam reinforcement was the principal item, weighing about 5 tons. This was assembled on blocking just above the floor-beam, and when all wired was lowered into the form.

Floor concreting went on at the rate usually of about 70 ft. (half of a large span, 139 ft. c. to c. piers) per day.

FIG. 10. METHOD OF CONCRETING ARCH RIBS

Thus the forms amounted to about 10 days of floor work—about the normal time of stripping. In one instance the whole 139-ft. length was concreted in a day of 8 hr., taking 350 cu.yd.

Rubbing Concrete Surfaces

All surfaces that would be seen in an elevation of the bridge were rubbed by the use of a wooden float and water. This work was done as soon after the concrete was poured as was possible to strip forms. On all walls where

no stresses were being carried by concrete the forms were stripped within 24 hr. and the concrete rubbed. Thus on this basis all surfaces shown as an elevation of the bridge were rubbed within 24 hr. after the concrete was poured. In addition to this all of the piers were rubbed to the springing line, as this portion of the work is very easily seen from the ground. None of the surfaces on the underside of the arches were rubbed, nor those underneath the floor system.

Rapid Concreting Record

The usual time required for pouring a pair of arch ribs (the westerly two ribs of one span) was 7 to 8 hr. This involved 320 cu.yd. of concrete in the case of the large (128-ft.) arches.

Much faster concreting was done in some of the pier work. In one pier 539 cu.yd. was placed in 9 hr.—a depth of 29 ft. of concrete. The South plant did this work, with a 25-ft. Smith tipping mixer.

In the case of this pier it was found that the concrete was still quite fluid 12 ft. down, and pasty to stiff 18 ft. down, a depth corresponding to about 5 hr. run. But the concrete materials were heated, which should accelerate the set.

There was little trouble from clogging of the chutes. The North plant in fact has plugged only once during the season. The concrete was of several mixtures and used three sizes of stone—1-in. for the superstructure, 1½-in. for retaining-walls, and 2-in. for piers and footings. The larger sizes gave a little more trouble in the chutes than the smaller.

Progress of Construction

The work accomplished in 1914 was: West half of south abutment, piers 16 and 17, and half the height of piers 12 and 14 concreted, and some further excavation made and two footings poured.

In February, 1915, the North concreting plant was put up. Early warm weather allowed concreting to begin Mar. 8, on pier work. The first arch was poured Apr. 13 and the last one July 13—just three months' time—including all four ribs in three of the spans (pier 12 to 15). Floor concreting began May 9 and was finished July 21, a total of 1726 ft. in length, all of it on only the west half.

Floor work is now in progress in the three spans whose cast ribs are in place, and some footing excavation is being done around the piers of the old viaduct. By the middle of August it is expected that the new viaduct will be carrying traffic and the demolition of the old one begun. As already stated, the contractors expect to finish the entire work by the end of the year. The paving is a separate contract.

Work is now one week ahead of the schedule made out last winter for the season's work. This gain was made in spite of a net loss of a week from delay of materials, etc.

The foregoing is based on information given by C. S. Smith, superintendent for Bates & Rogers Construction Co. on the work, with respect to the construction, and by A. W. Zesiger, Bridge Engineer of the county, as to the design. Mr. Zesiger is responsible for the design, under W. A. Stinchcomb, County Engineer. W. H. Bake, is resident engineer for the county.

Enlarging an Irrigation Canal

By Kenneth A. Heron*

The main canal of the Modesto Irrigation District, California, was originally built to carry 535 sec-ft., but it was found to have a capacity of less than 300 sec.-ft., when first used in 1904. Since that time it has been enlarged several times, until at present it is being constructed to a final capacity of 2000 sec.-ft. The canal diverts water from the Tuolumne River at the La Grange Dam and for the first mile or so is located on a steep hillside about 100 ft. above the river bed. This first mile was the most difficult to locate and construct in the first place, and since construction it has presented the great obstacles to be overcome when enlargement was considered. Originally, the first 4000 ft. consisted of a timber flume laid on a shelf excavated in the hillside (Fig. 1). The canal capacity at that time is said to have been about 250 sec.-ft.

During a long period of litigation and financial trouble in the district, when the money could not be obtained to complete the irrigation works, this flume stood with very little water in it, and decay was rapid. When the time to replace it arrived, however, conditions in the district were better and the timber structure was taken out entirely and a concrete-lined canal section, as shown in Fig. 2, was substituted. This section had a varying width of

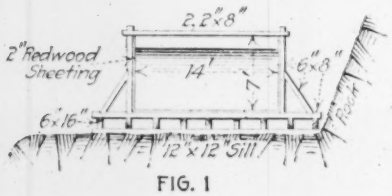


FIG. 1

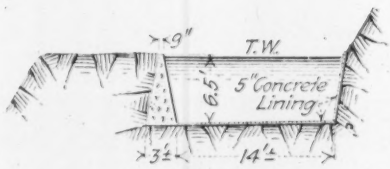


FIG. 2

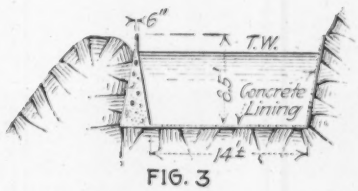


FIG. 3

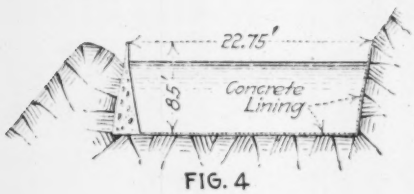


FIG. 4

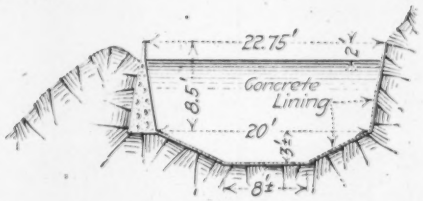


FIG. 5

FIGS. 1 TO 5. THE DEVELOPMENT OF AN IRRIGATION CANAL

Fig. 1—First stage: A timber flume. Fig. 2—Flume replaced by concrete-lined canal. Fig. 3—Lining raised to increase capacity. Fig. 4—Canal widened from 14 to 20 ft. Fig. 5—Canal deepened 3 ft. at center

*Irrigation Engineer, Modesto, Calif.

14 or 15 ft., a lining about 6 in. thick and a concrete wall on the lower side having a gravity section where there was no bank. This was backfilled with rock and earth, and the whole canal was located farther in the hillside than was the first structure. The capacity of this section was about 400 sec.-ft.

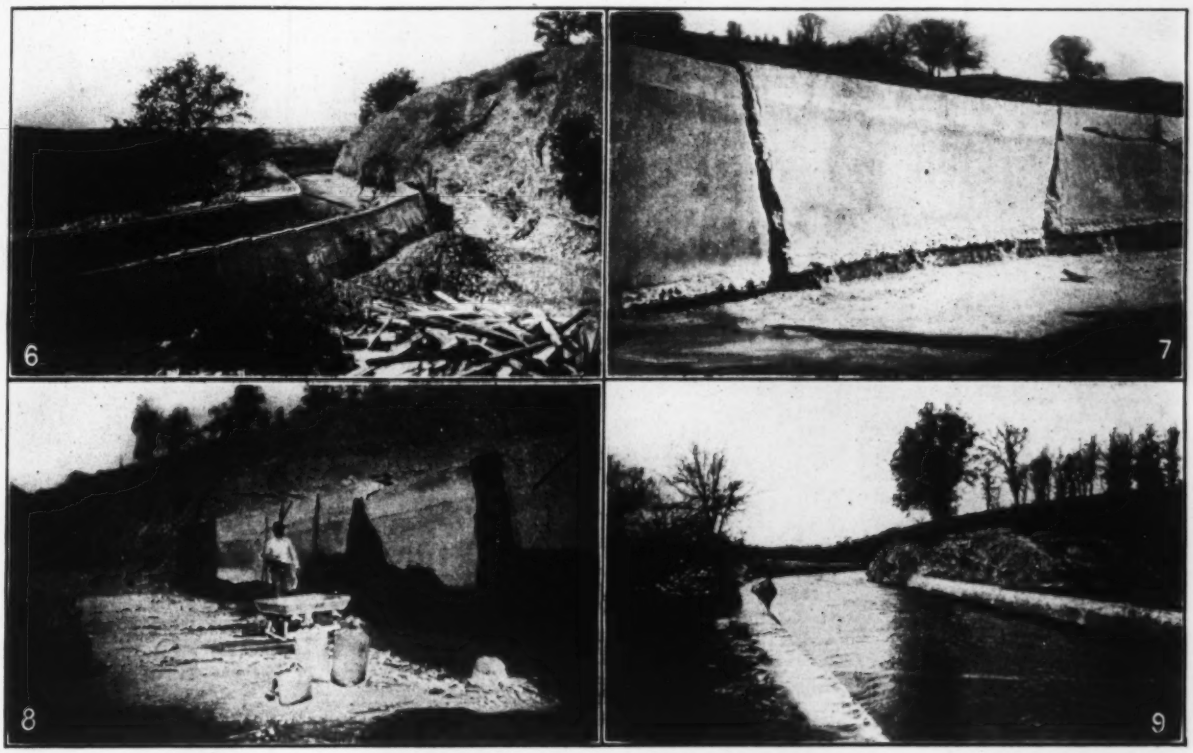
As the district developed and more land was brought under cultivation it was necessary to "crowd" the canal as much as possible, until it became customary to allow very little freeboard. The danger of the water topping the wall and washing out the backing and the necessity of obtaining more water led the district authorities to raise the concrete walls and lining about 2 ft. (Fig. 3). When this work was completed the canal capacity was increased about 100 sec.-ft. The rapid development of the district and the bringing of more lands under irrigation again required that the canal capacity be increased and in 1908 steps were taken to enlarge the size of the canal once more. Owing to certain fixed conditions at the headworks the hydraulic grade could not be raised without great expense, and it was decided to widen it to 20 ft. (Fig. 4). To do this it became necessary, in those portions of the canal which were concrete-lined, to tear out one wall, make the necessary excavation and replace it in the proper position.

This was done in places by excavating behind the wall to be moved and then carefully dynamiting it to break it into pieces of such sizes as could be easily pushed out on blocking with jacks. When moved to the proper position, the wall sections were carefully adjusted to fit as closely as possible and all cracks were plastered with cement mortar. New concrete was placed under the sections for foundations. The backfill was then placed behind the wall. Because of the care with which the work was done no more leakage developed than if the whole wall had been molded in place, and in appearance it is just as substantial. The capacity of the new canal section was approximately 800 sec.-ft.

Since this work was done the development of the district has been very rapid, and the recent construction of a reservoir which is supplied by this canal, together with new lands to be brought under cultivation, led the district authorities a year ago to call for plans and estimates for a canal of 2000 sec.-ft. capacity. At the time I was called upon to make surveys for this enlargement, two plans were under consideration. One called for the removal of 80,000 cu.yd. of rock and the placing of 7500 cu.yd. of concrete, at a total cost of $250,000. This plan necessitated widening the canal 10 ft. on the upper sides and lining it with concrete. As the average rock cut would be about 28 ft., the difficulty of the work is apparent.

The other plan considered consisted of a tunnel which would reach from the canal headworks to a point some 6000 ft. down the canal. The length of the tunnel was placed at 4000 ft., and the estimated cost was $500,000. It was found that by lowering the present canal bottom about 3 ft. and at this depth reducing the bottom width to 80 ft. and lining the entire section, a water area of about 180 sq.ft. would be secured below a 2-ft. freeboard.

There is sufficient fall in the first two miles of the canal to secure a velocity of 11.1 ft. per second and a canal capacity of 2000 sec.-ft. The cost of carrying out this work is estimated at $135,000 and new improvements are being made in line with this plan (Fig. 5).



FIGS. 6 TO 9. BREAKING THE CANAL WALL INTO SECTIONS AND MOVING IT BACK

Fig. 6—Wall bared in rear and broken into sections. Fig. 7—Broken wall moved to new position. Fig. 8—Pieces of wall set up and joined. Fig. 9—Widened canal

Motor Race-Track at Chicago

SYNOPSIS—This new two-mile automobile speedway is the first to have a wood deck, or track, supported on timber trestling. Rapid construction was a special feature of the work, as not only the track but also buildings, sewers, drains, water supply, etc., had to be provided complete and ready for use in very short time, in order to be ready for races on a given date.

The automobile speedway at Maywood, Ill., just outside the western limits of the City of Chicago, which was opened June 26, is said to be the first to have a timber floor, or track, supported on timber trestling. It proved very satisfactory during the races on the opening day, and the maximum speed attained exceeded any previous records.

The track has a length of two miles on the measuring line (near the inner edge) and consists of two parallel straight sides connected by end curves. Its major and minor axes are about 4053 ft. and 2060 ft. respectively. Because a railway cuts diagonally across one end of the oblong site the end curves or turns are not symmetrical. The north turn has a long curve of 5° 48′ united to the tangents by short spirals. The south turn is composed mainly of two long spirals united by a short length of circular curve. The spirals have 100-ft. chords, with a difference of 38′ 40″ in each station. The long spirals Nos. 1 and 2 reverse at stations 11 and 13 respectively, being symmetrical on opposite sides of these stations, except that the lengths are not the same. The arrangement of the turns and spirals is shown in the table at the bottom of the page.

The instructions for survey work required all tangents to be run out and checked before commencing to run spirals and curves, and points of curves and spirals to be located by measurements from the intersections. All work was to be checked by back deflections, and coördinates measured if further check seemed desirable. Each station was marked by a gas-pipe post driven so deep as not to be disturbed by excavations for footings. The grading excavation was done in advance of the final location measurement.

The width of the track proper is about 65 ft. on the straight, increasing to 75 ft. on the banked turns. Inside of this, on the curves or turns, is an 8-ft. dead space (which is level all the way round). The transverse inclination, or banking, on the turns is about 1 on 3 (or 22°) on the circular curves and runs out on the spirals with a 3% grade along the outer, or high, side. Vertical curves of 150 ft. length connect the ends of this grade with the horizontal portions of the higher and lower ends. The banking is identical at both ends in spite of the difference in curves. This is due to the fact that while, theoretically, a steeper banking would be required for the sharper curves at the south turn, practically, any steeper slope might be unsafe for a car having to slacken speed on the curve.

The banking was designed originally according to accepted formulas for speed and weight, but in construction the results thus obtained were modified on the basis of empirical data and according to the advice of experienced drivers. It was designed for a speed of 75 m.p.h., but the maximum speed record upon it was at the rate of

FIG. 1. THE NORTH TURN OF THE MAYWOOD TWO-MILE AUTOMOBILE SPEEDWAY (NEAR CHICAGO)

The view shows the banked west end of the curve, where it runs (in the foreground) into the level home-stretch. The maximum elevation is about 25 ft. in a width of 75 ft. The floor track is of 2x4-in. timbers, placed on edge

LAYOUT OF THE MAYWOOD AUTOMOBILE SPEEDWAY (CHICAGO)

	Curve	Radius	Cen. Angle	Length, Ft.
Tangent, home stretch	....	....	.....	1,335
Spiral curve	.....	.....	60° 30′	1,400
Circular curve	4° 21′ 55″	1312 ft.	29° 29′	675
Spiral curve	....	.....	90°	1,800
Tangent, back stretch	....	....	.....	1,450
Spiral curve	.....	.....	23° 12′	800
Circular curve	5° 48′	988 ft.	133° 19′	2,300
Spiral (to home stretch)	....	....	23° 12′	800
Total length (two miles)				10,560

SPIRALS

	No. of Chords	Radius in Feet: Entering	Middle	Leaving
No. 1. From home stretch	14	8890	(Sta. 11) 808	1111
No. 2. Into back stretch	18	1111	(Sta. 13) 684	8890
No. 3. From back stretch	8	8890	.....	1111
No. 4. Into home stretch	8	1111	.....	8890

over 100 m.p.h. The average speed for the 500-mile race on June 26 was 97.58 m.p.h.

The combined change in longitudinal grade and transverse inclination forms a warped surface, which is given by cutting the supporting posts to carefully calculated lengths.

Near the starting point is the row of 35 supply pits, with a stretch of concrete paving 20 ft. wide between them and the inner side of the track. Here the cars stand while those in charge of them are taking supplies, renewing tires, making repairs, etc.

Particulars of Speedway-Track Construction

The deck, or flooring, of the track consists of longitudinal 2x4-in. tamarack sticks placed on edge. They average about 16 ft. in length, and each course laps the other about 24 in., the line of joints running diagonally across the track. The floor rests on joists 2x12-in., spaced 24 in. c. to c., on the straight stretches. The floor timbers are spiked together at intervals. In case of wear of any one stick, it can be cut out (spikes and all) and a new one dropped into place, the latter being then spiked or toe-nailed from below. With the exception of the track all timbering is of pine.

Concrete pedestals, or footings, 30 in. square and set 3½ ft. below the ground surface extend 12 in. above the ground line and support the framing for the track. There are five rows of these. On the level tangents they are spaced 12 ft. 6 in. c. to c. longitudinally, and carry 8x12-in. stringers upon which the transverse joists are laid. On the turns the pedestals support the posts of transverse bents, as shown. These posts are 10x12 in., each secured to its pedestal by a 1-in. pin 12 in. long. As the bents are placed radially the concreting and carpenter gangs had to be supplied with plans showing the location of the pedestals as well as the elevations of the warped surface of the deck.

Each bent has a cap composed of two 3x12-in. planks framed into the posts; upon these are 3x12-in. stringers spaced 5 ft. 3 in. apart and braced by cleats. Across the stringers are the track joists, 2x10-in., with bridging between them. All bents are thoroughly braced, and along the back and front of the bents is diagonal bracing in every fourth panel, forming braced towers. At intervals of 100 ft. a fire-stop is made by nailing metal lath to both sides of a bent and covering it with plaster. This extends from the ground to the deck.

The posts on the outer, or high, side are extended 20 in. above the track deck, and to their faces is bolted an oak guard timber 6x12 in. Short intermediate posts alternate with the main posts, so that the rail is supported at intervals of 6 ft. 3 in. Along the inner side of the track is a similar guard timber, carried by short posts 6 ft. 3 in. c. to c. These guards are to check any runaway cars. At the grandstand and bleachers a screen of wire netting is erected to stop tires that may be thrown off by speeding cars.

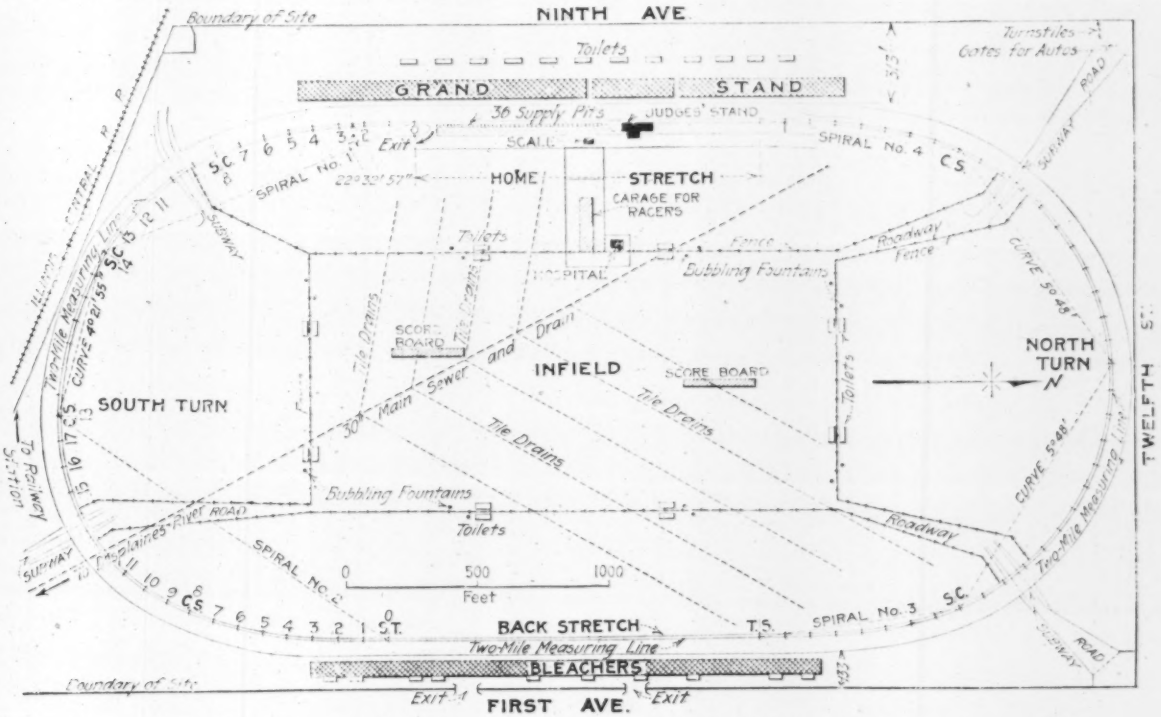


FIG. 2. PLAN OF THE TWO-MILE AUTOMOBILE SPEEDWAY AT MAYWOOD, ILL. (NEAR CHICAGO)
Note the unsymmetrical layout of the two turns, due to the shape of the site

Four subways pass under the turns of track and give access to the infield. Here special construction is required, the spacing between bents being increased to 17 ft. 6 in. for the two driveways. The posts are 12x12 in., with cast-iron caps for a pair of cap timbers 8x18 in. Across these are laid stringers 4x14 in., 45 in. c. to c., upon which the track joists are placed. Each subway has two 15-ft. driveways and two 6-ft. sidewalks at a higher level. The driveways are paved with concrete and have approach grades of 5%. Each is divided by a central concrete curb to keep vehicles in line.

To provide facilities for the accommodation of a crowd of 100,000 people or more was no small part of the work. Water is obtained by connection with the mains of the village of Maywood, a 6-in. main being laid into the grounds. This is under a pressure of 40 lb. and provides fire-protection service. Pipes are laid into all the buildings and along the bleachers and the grandstand, with bubbling fountains at intervals of 250 ft. The 6-in. main extends close around the outside of the track, with fire hydrants 400 ft. apart. There are about five miles of water pipe.

Numerous free toilet rooms are provided, with first-class fixtures. The buildings are of wood, but it is proposed to place concrete floors later. From these toilets extend separate vitrified tile sewers, connecting with a 30-in. main trunk drain discharging into the Desplaines River.

The ground being a heavy black loam, quickly converted into mud, it was necessary to drain the site to keep the roadways and infield serviceable in wet weather. There are about 12 miles of drains, laid out in herringbone fashion, with lines of 5- and 6-in. pipe 200 ft. apart and connecting with the 30-in. main drain running diagonally across the site. The trenches were excavated to a minimum depth of 30 in. by trenching machines and by hand.

To drain the depressed subways, each has a sump in the middle of the roadway (at one end) with a vertical-shaft 2½-in. centrifugal pump driven by a 5-hp. gasoline engine on a platform level with the dead space of the speedway track. Later, these will be operated by electric motors.

The grandstand is 2240 ft. long and seats about 60,000 persons. It has six-post bents 12 ft. c. to c. A steel roof extends for the full length, having trusses 24 ft. apart. These are supported on two rows of posts, the front ends of the trusses extending as cantilevers in order to avoid the use of posts near the front of the grandstand. The "bleacher" stand is 1940 ft. long, and will accommodate about 40,000 persons. Both stands are designed to carry safely a load of 200 lb. per sq.ft., with allowance for movements of crowds. These structures will be dealt with in a separate article.

Scoreboards, Fences and Roadways

Two scoreboards in the infield are conspicuous structures, each being 275 ft. long and 65 ft. high. These were built entirely of wood, owing to the short time available for their construction. They have on each side rows of openings for roller curtains on which are painted figures 4 ft. high. These are operated by men on the inside. The scoreboards show the spectators the progress of the races and the performance or standing of the competitors. A complete telephone system connects the score-men with the time-takers at different points along the course, and with the judges' stand.

A tight board fence 10 ft. high and 3½ miles long surrounds the site. Entrances are provided at three corners, and there are additional exits at intervals. The automobile entrances have four or five gateways 16 ft. wide, with men in charge to collect tickets. A balcony in the entrance structure provides for an inspector, who can watch the movement of the lines of vehicles. To avoid crush, no change is given at the entrance gates for pedestrians. Tickets or the exact fee are handed in at the turnstiles.

The main driveways are of concrete. Those of the infield, etc., are of screenings on a bed of cinders well rolled into the graded and rolled surface of the earth.

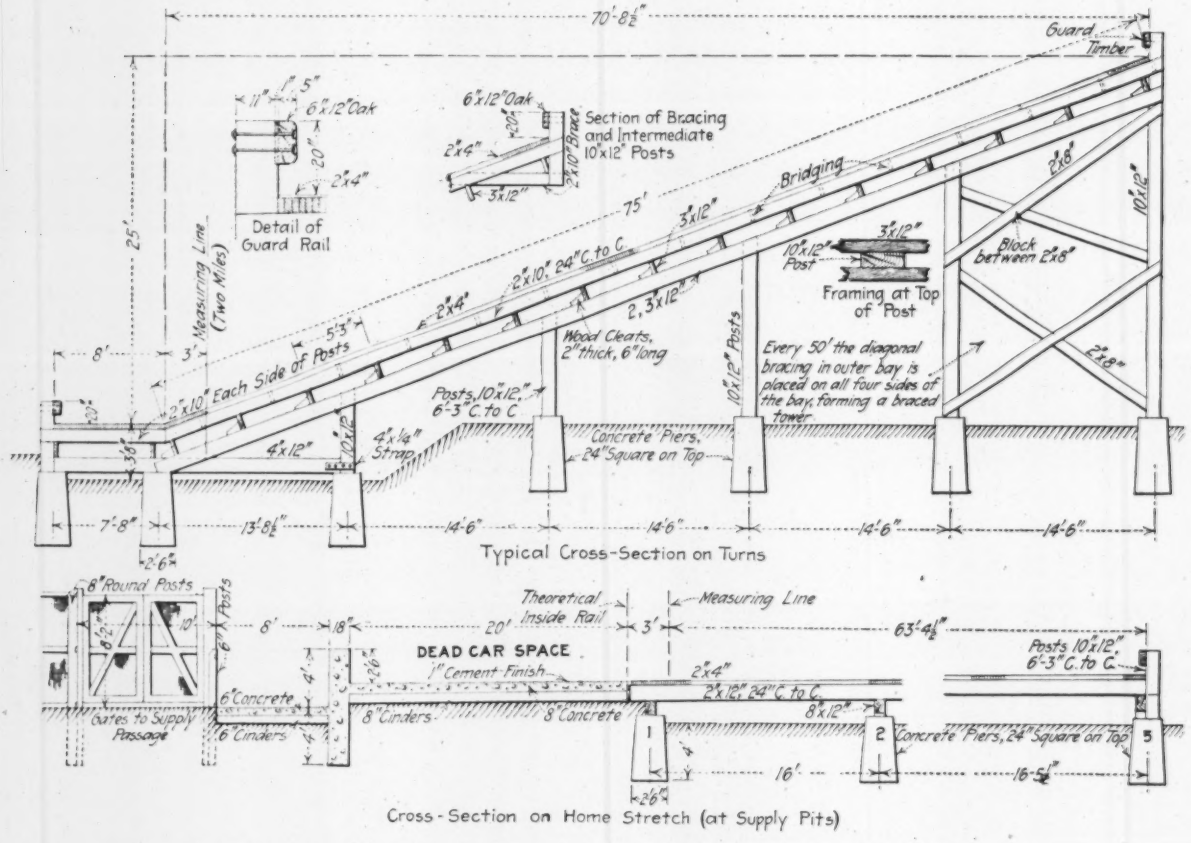

70'-8½"
Guard Timber
Section of Bracing and Intermediate 10"x12" Posts
Detail of Guard Rail
Bridging
Measuring Line (Two Miles)
Each Side of Posts
2"x10" 24" C. to C.
Wood Cleats, 2" thick, 6" long
Framing at Top of Post
Block between 2"x8"
Every 50' the diagonal bracing in outer bay is placed on all four sides of the bay, forming a braced tower
Posts, 10"x12", 6'-3" C. to C.
4"x¼" Strap
Concrete Piers, 24" Square on Top
Typical Cross-Section on Turns
8" Round Posts
Theoretical Inside Rail
Measuring Line
DEAD CAR SPACE
½" Cement Finish
6" Concrete
8" Cinders
8" Concrete
Gates to Supply Passage
Posts 10"x12", 6'-3" C. to C.
Concrete Piers, 24" Square on Top
Cross-Section on Home Stretch (at Supply Pits)

FIG. 3. TYPICAL SECTIONS OF THE SPEEDWAY ON TANGENTS AND TURNS

Plank roadways were also provided inside the grounds temporarily. The site was reached by rough gravel and earth roads, and in order to provide for the heavy teaming the contractor was obliged to pave the main approaches with broken stone. These macadam roads were well rolled and later oiled to give a compact surface and avoid a dust nuisance during the heavy automobile traffic on the days of the races.

Details of the Construction Work

The Speedway Park Association let the general contract to the Shank Co., of Chicago. This contract covered all the work (track, buildings, stands, sewerage, water-supply, etc., complete), with instructions to have the speedway ready for the races set for June 19. The material included some 13,500,000 ft. b.m. of timber and 20,000 cu.yd. of concrete. The track alone required 7,000,000 ft. b.m. of timber and 7000 yd. of concrete. The necessity of framing the speedway bents to give the warped surface of the turns made this part of the work relatively slow and difficult. All framing and cutting of timber was done on the site. Material was brought in by wagons and motor trucks, and this traffic made it necessary to keep a repair gang at work to maintain the approach roads in passable condition. A sawmill was erected as part of the plant.

Grading machines were used to level the ground and form the roadways, and a trenching machine excavated the trenches for drains, sewers, and water mains. Post-hole diggers were used to excavate the holes for the concrete pedestals.

For the numerous small pedestals and footings and the concrete roadways, a number of small concrete mixers were used, being shifted from place to place. A part of the time a night shift was worked by the aid of acetylene torches on stands 10 or 12 ft. high. The number of men at work ranged from 500 to 1500.

The contract with the Shank Co. was signed April 19, and work was started April 21. The track was undertaken first and was completed on June 5. A night shift was tried (for placing the 2x4-in. deck only), but a few nights' experience proved this to be inefficient, and it was given up. The actual working time on the track was a little more than a month. In the remaining time all the other work was finished with the exception of 120 ft. of timber construction of the grandstand.

Heavy rains delayed work at the end, but the Chicago street-car strike led to the races being postponed for one week, to June 26, by which time the work was practically completed, except for finishing touches.

The general plans were prepared by Graham, Burnham & Co., of Chicago, architects for the Speedway Park Association. The Shank Co., of Chicago, had the contract for the entire work, and maintained a staff of engineers who laid out, detailed and superintended all the construction work and the structural designs. The president of this company, George H. Shank, personally supervised the work in the field; Frederick Grim was Chief Engineer; Alfred H. Marshall, Principal Assistant Engineer; C. T. McClelland, Field Engineer, and Charles A. Shank, General Superintendent.

The fencing, walks and scoreboards were built by Van De Venter & Rider, as subcontractors. The steelwork for the cantilever roof of the grandstand was built by the Hansell-Elcock Co., but was erected by the general contractor.

With so much work of so many kinds to be done in a short time, and with an absolute time limit (the day of the races), it was important that there should be no delay because of friction or misunderstanding between the general contractor and the owners. For this reason C. F. Wiehe, F. N. Foster and D. B. Reid, officials of the Speedway Park Association, composed an Executive Board which advised in all matters of policy and administration.

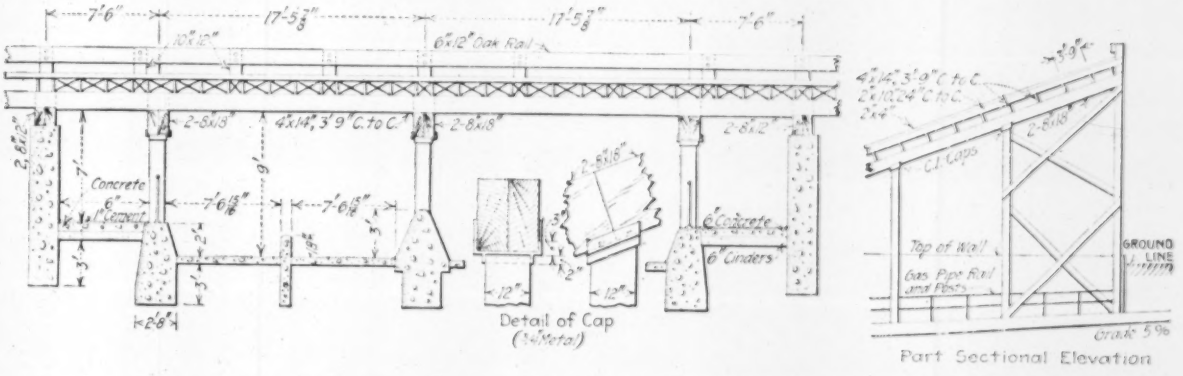


FIG. 4. SUBWAY BENEATH THE TRACK OF THE MAYWOOD SPEEDWAY

Manufacturing Portland Cement in Brazil—A government concession to use certain large deposits of shells in the Bay of Bahia, suitable for use in the manufacture of cement, is held by two residents of Bahia, Brazil. United States Consul Robert Frazer, Jr., states that these men claim they can manufacture a first-class cement at a cost of $2.50 to $2.75 per bbl., as against the minimum cost in normal times of $4.32 for an ordinary grade of foreign cement, duty paid. The project includes the erection of a factory in a small harbor opening off the large bay, at a point where steamers can approach to within 100 ft. of the shore. Near this site are large deposits of sea shells mixed with coral and a suitable clay. One of these beds of shells is 1½ mi. long by ¾ mi. wide, and has been tested to a depth of 7½ ft.

A Proposed Standard Box Car of steel construction has been designed by the Committee on Car Construction of the Master Car Builders' Association and was reported at the annual convention at Atlantic City for criticism. The car is of steel construction throughout, with side sheathing of steel sheets ⅛ in. thick and end sheets ¼ in. thick. The cubic volume of the car body under the carlines is 3096 cu.ft. The principal dimensions are as follows:

Length of frame over striking casting	42 ft. 6 in.
Width over sheathing	9 ft. 1¾ in.
Length, inside	40 ft. 6⅛ in.
Width, inside	8 ft. 6 in.
Height, inside	9 ft. 0 in.
Height, from rail to bottom of bolster	2 ft. 6 in.
Height, from rail to floor	3 ft. 8½ in.
Height, from rail to top of running board	13 ft. 4½ in.
Height, from rail to top of brake staff	14 ft. 2 in.
Width, at eaves	9 ft. 2⅜ in.
Height, at eaves	12 ft. 5¾ in.

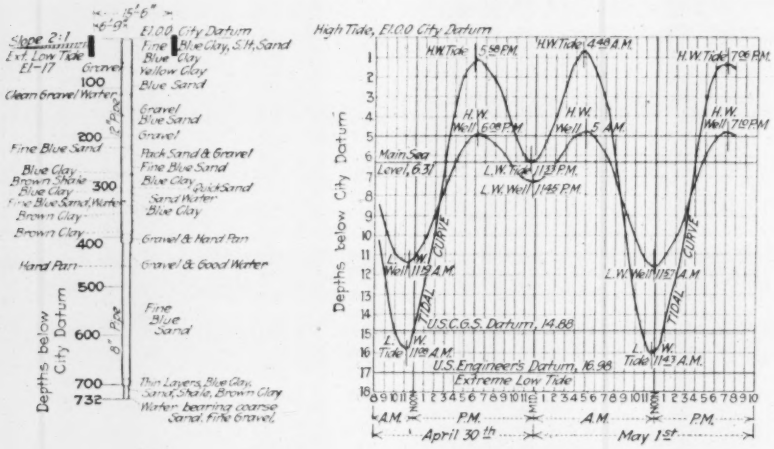
The underframe of the car has been designed to withstand safely a total end force of 250,000 lb.

Tidal Influence on Artesian Well at Seattle

By H. M. Chittenden*

The Port of Seattle has recently sunk a deep well on the shore of Elliott Bay to provide water for a cold-storage plant which it has erected there. The well is 732 ft. deep. It consists of a 12-in. casing down to a depth of 400 ft., an 8-in. casing from that point to a depth of 700 ft., and a 6-in. casing 20 ft. further. No satisfactory supply of water was found until the last water-bearing stratum was pierced. The supply found there is abundant in quantity, satisfactory in quality and entirely fresh. The water rises to the surface of the well without pumping.

A singular fact connected with this well is that it is subject to tidal influence. The water in the casing rises and falls with the tide in the harbor, the oscillations being almost synchronous and the range in the well being nearly 50 per cent. that of the tide. The accompanying diagram shows the well and the strata through which it passes, and also the curves of oscillation in the harbor and in the well. There is no opening in the casing within 400 ft.



TIDAL EFFECT IN WELL ON SEATTLE WATERFRONT

of the bottom of the harbor, while the foot of the tube is nearly twice that distance from salt water. The water from the well is totally different in quality from that in the harbor. A mile or so out from the shore the harbor bottom reaches a depth of some 300 ft., but the slope from the shore is gradual.

It is difficult to account for this tidal effect in the well. It certainly does not come from any direct aqueous communication with the bay. Infiltration through such thickness of strata would be impossible, or if possible, it could not act so quickly. Moreover, the difference in quality of water precludes any such hypothesis. The only explanation which occurs to the writer is that the bed of the harbor rests like a saucer in the stratum of water which furnishes the supply to the well. The vertical pressure on the bed of the harbor varies with the tide from an average of over 3 tons per sq.ft. to an extreme of over 5 tons. It is possible that this change of pressure is communicated through the harbor bed to the water stratum underneath and thus acts on the well. As such a water stratum could hardly be entirely uninterrupted by harder material, and as the harbor bed cannot be wholly elastic, the full effect of change of pressure on the bed could hardly be felt in the stratum of water underneath. This may account for the much smaller oscillation in the well than that of the tide.

*Brigadier-General, U. S. A., retired, 2010 Broadway, N., Seattle, Wash.

Some Provisions of the New Highway Law of Ohio

A revision of the laws governing highway construction and maintenance in Ohio has been accomplished, and on Sept. 5 an entirely new code went into effect. The new law comprises 15 chapters, 305 sections, and occupies 124 pages of text. It is obviously a series of compromises and an attempt to keep as much of the old scheme of highway control as possible, yet there are several distinctive provisions which should advance good roadbuilding in this state, and the most important is better pay for the county road officials.

There are still three partly independent roadbuilding authorities—the township trustees, the county commissioners and the state highway commissioner. Each authority has its own employees, who are rather curiously interrelated, as the following abstract will show. The township trustees hire their own employees directly or through the county highway superintendent, the county commissioners do their work through the county surveyor (highway superintendent), an elective officer, and the highway commissioner, of course, has his own employees.

The following section of the law covers the roads under the jurisdiction of the township trustees:

Township roads shall include all public highways of the state other than state or county roads as herein defined, and the trustees of each township shall maintain all such roads within their respective townships; and provided further, that the county commissioners shall have full power and authority to assist the township trustees in maintaining all such roads, but nothing herein shall prevent the township trustees from improving any road within their respective townships, except as otherwise provided in this act.

The township trustees are authorized to levy taxes not exceeding three mills per dollar for improving, dragging, repairing or maintaining any public road which they may designate. For such work they "direct" the county highway superintendent (county surveyor) to make surveys, plans and specifications, which may or may not be adopted by the trustees. The township trustees may then let contracts for roadwork and appoint some competent person or persons "to act under the general direction of the county highway superintendent," as an inspector. The inspector's pay is not to exceed $4 per diem, and is paid by the township.

Township Highway Authorities

Each township is divided into not less than one nor more than four road districts. For each such district the trustees appoint a township highway superintendent, who, "under the direction of the township trustees," has control of the roads in his district and the keeping of them

in good repair. He is appointed by the trustees to hold office until removed, but his removal may be accomplished either by the trustees or by the county highway superintendent "for incompetence or gross neglect of duty." His compensation is not fixed by law. He is required to make an annual report to the county highway superintendent, and to file a duplicate report with the township trustees. He is also subject to the orders of the county highway superintendent "to attend to any demonstration for the purpose of exhibiting the best method of dragging highways." Otherwise the township superintendent does not appear to be under the immediate supervision of the county superintendent, and there is no provision in the law to prevent the township trustees from reappointing a township superintendent who has been removed by the county superintendent.

County Highway Authorities

County roads are described as follows:

> County roads shall include all roads which have been or may be improved by the county by placing brick, stone, gravel or other roadbuilding material thereon, or heretofore built by the state and not a part of the intercounty or main market system of roads, together with such roads as have been or may be constructed by the township trustees to conform to the standards for county roads as fixed by the county commissioners, and all such roads shall be maintained by the county commissioners.

The board of county commissioners is given authority to construct or improve any road except the intercounty and main market roads (state highways). The county commissioners may coöperate with the township trustees, but nevertheless have jurisdiction over the trustees and may construct or improve roads on their own initiative or on petitions directed to them by land owners. The county commissioners "order" the county surveyor (highway superintendent) to make the necessary surveys, plans and specifications, but "the profile and grade" are subject to approval of the commissioners. The county highway superintendent is then required to make estimates, supervise contracts and do other necessary engineering work.

The law provides that the present elective county surveyors shall be the county highway superintendents. The county highway superintendent is to give his whole time to the county, and his salary is to be computed as follows: "One dollar per mile for each full mile of the first 1000 mi. of public roads in the county, and in addition $10 for each full 1000 of the first 15,000 of the population of the county; $30 per 1000 for each full 1000 of the second 15,000; $25 per 1000 for each full 1000 of the third 15,000; $15 for each full 1000 for the fourth 15,000; and $5 per 1000 for each full 1000 in excess of 60,000." Thus a county of 1500 mi. of roads and 75,000 population would pay its highway superintendent a salary of $1000 + $10 × 15 + $30 × 15 + $25 × 15 + $15 × 15 + $5 × 15 = $2725 per annum.

This salary covers all services for township, county or state (as hereafter described), and is paid out of the county treasury. The county superintendent is allowed necessary expenses and such assistants as the county commissioners see fit to provide.

Where the county superintendent also has charge of the state highways in his county, one-fifth of his salary is paid by the state. The state highway commissioner may or may not designate the county superintendent to take charge of the state highways, but if for any reason he does not do so the county superintendent loses one-fifth of the salary provided for in the foregoing paragraph.

The state highway commissioner may appoint an engineer other than the county superintendent to have charge of the state work in the county. This, however, can apparently be done only after the state highway commissioner has filed with the county commissioners a written statement to the effect that the county superintendent is not qualified to handle the state work; but the county superintendent, being an elective officer, the county commissioners are powerless to remove.

The county superintendent is required to make a report at least once a year to the county commissioners, a copy of the report to be filed with the state highway commissioner. He is also to furnish such special reports as may be called for by the county commissioners or the state highway commissioner, or to attend conferences with the state highway commissioner if necessary. He is also required to make an annual report for the year ending Nov. 15 to the state highway commissioner, a copy of which is filed with the county commissioners. The law does not make it clear whether or not this report shall refer exclusively to state highways; it shall contain "such matter and in such form as may be prescribed by the state highway commissioner."

In general the county highway superintendent seems to be in full charge of all the roadwork in his county. He "may request advice and assistance from the state highway commissioner in all matters relating to his duties," and by the same section of the law "shall be governed in the conduct of his work by the instructions of the state highway commissioner, as issued from time to time for the guidance of county highway superintendents." At the same time the county superintendent "shall from time to time issue such instructions to the township superintendents as he deems best."

Again, it is provided that the county highway superintendent, "under the direction of the state highway commissioner, shall provide for the maintenance and repair of the roads of the county, under such system as may be deemed expedient, so that each section of the highways of the county shall be under proper supervision and be effectively and economically improved, maintained and repaired."

State Highway Authorities

The following section of the law defines the state highway authority:

> State roads shall include such part or parts of the intercounty highways and main market roads as have been or may hereafter be constructed by the state, or which have been or may hereafter be taken over by the state as provided in this act, and such roads shall be maintained by the state highway department.

The state highway department is declared to be established "for the purpose of affording instruction, assistance and coöperation in the construction, improvement, maintenance and repair of the public roads and bridges of the state." The governor appoints the highway commissioner, whose salary is $4000 per annum, and the commissioner appoints three deputy commissioners, whose annual salaries are $3000 per annum. One of the deputies is designated as chief highway engineer.

The law provides that all these deputies must be competent civil engineers, one to be experienced in road con-

struction and improvement, one experienced in road maintenance and repair, and the third experienced in the design, construction, maintenance and repair of culverts and bridges. Their necessary expenses, not exceeding $1200 per annum, are allowed. The highway commissioner may also appoint, within the limits of his appropriation, as many division engineers, superintendents and inspectors as are necessary. The maximum salary of a division engineer is $2500 per annum.

The duties of the state highway commissioner are prescribed as follows:

The state highway commissioner shall have general supervision of the construction, improvement, maintenance and repair of all intercounty highways and main market roads, and the bridges and culverts thereon. He shall aid the county commissioners in establishing, creating and preparing suitable systems of drainage for highways, and advise with them as to the construction, improvement, maintenance and repair of highways; and he shall approve the design, construction, maintenance and repair of all bridges, including superstructure and substructure, and culverts or other improvements on intercounty or main market roads; and in the case of bridges and culverts on other roads, when the estimated cost thereof exceeds $10,000, the plans therefor shall be submitted to and approved by him, before contracts are let therefor. He shall cause plans, specifications and estimates to be prepared for the construction, maintenance or repair of bridges and culverts when so requested by the authorities having charge thereof, and he shall cause to be made surveys, plats, profiles, specifications and estimates for improvements whether upon state, county or township roads. He shall make inquiry in regard to systems of road and bridge construction and maintenance wherever he may deem it advisable and conduct investigations and experiments with reference thereto, and make all examinations, in his opinion, advisable, as to materials for road construction or improvement.

The state highway commissioner or the chief highway engineer "may call upon the county highway superintendent, at any time, to furnish survey maps and any other information that may be required," the information to be furnished in such form as the commissioner requires. The county superintendent, in turn, may call upon the township trustees or township superintendent to furnish a part of the information required by the state highway department.

A Covered Slip and Pier with Gantry Cranes for Handling Lumber

A new idea in the shipping and handling of high-grade mill lumber is being introduced by the Carpenter-O'Brien Co., of Jacksonville, Fla., which has lumber docks at Eastport, Fla., and Staten Island, N. Y. It includes special pier design, special mechanical handling equipment, special steamers, and the handling of lumber in unit packages instead of in loose pieces.

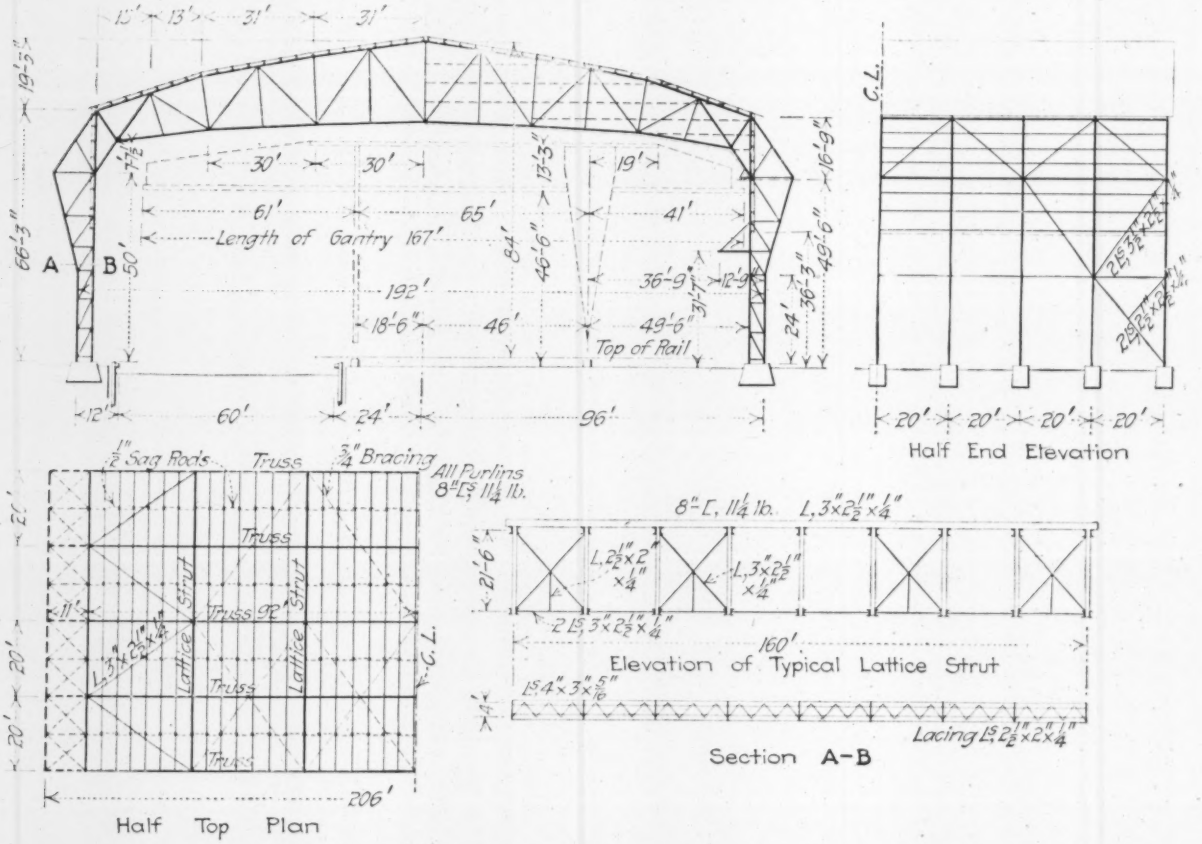


FIG. 1. STEEL SHED OVER STEAMSHIP SLIP AND PIER, STATEN ISLAND

In order to reduce the time of loading and unloading vessels, all lumber will be put up at the Eastport mills in "packages," or units, 4 ft. square and of varying length. These will be carried by a telpher line to a dock equipped with special loading machinery. There they will be placed on steamers having hatches arranged for convenient loading and a hold arranged for suitable stowing of the unit "packages." At Staten Island, the cargo will be unloaded in the same way and the units stored on the dock, to be loaded into barges for distribution as required.

In this way the lumber steamers (like the ore steamers on the Great Lakes) will spend but a small proportion

of their time in port. It is expected that they will make the round trip in eight days—six days at sea and one day in each port.

Another feature is the protection of the lumber (much of it kiln-dried) from rain and snow. For this purpose it will be handled entirely under cover, the pier shed extending over the slip. This arrangement is the same both at Eastport and New York, except that the shed at Staten Island was designed for a snow load in addition to the wind and dead loads, and with unit stresses, etc., as required by the Department of Docks. This design is shown in Fig. 1.

Pier, Shed and Gantries

The slip is 60 ft. wide and is covered by the pier shed for a length of 160 ft. The shed is about 184 ft. wide, with a clear height of about 65 ft. above the floor. Lateral stability of the structure is afforded by lattice columns, which widen toward the upper end and which transmit to the foundation the bending stress due to wind pressure. They are practically vertical trusses whose tops merge with the roof truss, as shown. The columns are spaced 20 ft. c. to c. The frame is sheathed with corrugated iron.

Within the shed are two 20-ton traveling gantry-cranes each 167 ft. long, carried by a tower 65x40 ft., giving cantilever arms of 61 ft. over the slip and 41 ft. at the rear (Fig. 1). There is a single line of rails on each side, and each leg of the tower is carried on two wheels. The maximum load per wheel is 50,000 lb. on the front (or water) side and 65,000 lb. on the rear side. The clear spacing between the legs is 26 ft. at the top, increasing to 40 ft. at the base, so that there is ample room for handling the "packages" of lumber. On the gantry travel two hoisting trolleys. The dock space between and beyond the legs of the gantry tower is available for storage.

The foundations of the dock at Eastport, Fla., are piers composed of groups of piles inclosed in concrete caissons, because of the presence of the teredo in the waters of the St. John River. The caissons are 6x10 ft. in plan, with 12-in. walls reinforced by horizontal and vertical steel bars. The piers on the slip side were constructed first, by sinking the caissons to a depth of at least 26 ft. below the bottom of the slip. The material was dredged out, and eight piles in each caisson were driven to refusal. The caisson was then filled with river sand to within 6½ ft. of the top, the sand being compacted by settling in water. The pier was completed by a heavy concrete cap in which the anchor bolts for the superstructure column were embedded. The piers on the slip side are protected by fender piles. This construction, shown in Fig. 2, was designed by Mr. Cline, of the Carpenter-O'Brien Co.

The foundation design for the Staten Island dock is shown in Fig. 3. After the slip and approach channel have been dredged to 65 ft. of water there remains only 7 ft. for soil over the rock, and the small penetration thus available for pile footings on the side adjacent to the slip creates a special problem. The same condition exists at the opposite side and is corrected here by banking and riprapping, as shown.

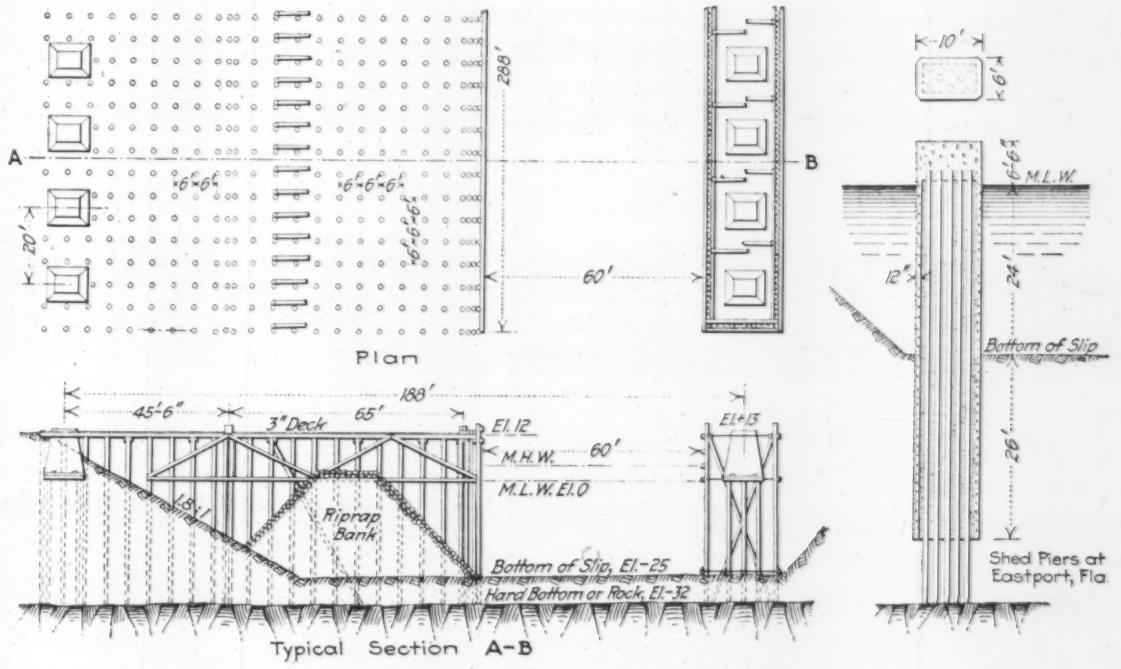


FIG. 2. FOUNDATIONS FOR PIER SHED AND FOR GANTRIES

The shed foundation on the slip side is a rock-filled fender crib with concrete pedestals for the columns. Although excessive thrust of the diagonal cross-timbers is not expected, it is provided for by two lines of longitudinal stringers and rails cross-connected by tie rods. The foundation for the gantries consists of close lines of piling, upon each of which are two tiers of stringers for the rails.

Personnel

The pier sheds were designed and built by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis. The gantry cranes and the telpher system from the mill to the dock at Eastport were built by the Pawling & Harnischfeger Co., of Milwaukee. The steamers were designed by E. S. Hough, consulting marine engineer, San Francisco, Calif.